Canada Mortgage and Housing Corporation
Société canadienne d'hypothèques et de logement

CMHC Helping to house Canadians

THE STUDY OF EMERGENCY RESPONSE SYSTEMS FOR THE ELDERLY

The Study of Emergency Response Systems for the Elderly

CMHC

This study was carried out by MacLaren Plansearch for the Research Division of Canada Mortgage and Housing Corporation under Part V of the National Housing Act. The analysis, interpretations, views and recommendations are those of the authors and do not necessarily reflect the views of the Corporation.

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ABSTRACT

Emergency response systems (ERS) are potentially important technological solutions for housing policy makers and providers to use as a means of expanding opportunities for the elderly to continue living independently in non-institutional settings.

This report describes, reviews and analyzes the existing and future role of emergency systems for the elderly in Canada. Based on an evaluation of existing emergency response systems, a generic description of the hardware and monitoring services currently available in Canada is provided.

The study included detailed interviews with users, geriatric practitioners and industry representatives. In addition a literature review, and an analysis of existing systems, with possible innovations is provided along with recommendations for technological improvements. The report concludes with generic criteria that define appropriate technology suitable for elderly users.

EXECUTIVE SUMMARY

It is widely known that the Canadian population is increasingly made up of an unprecedented number of older Canadians. Although longer life expectancy is an outstanding achievement of our times, it has brought with it critical social and economic questions about meeting the needs of the elderly. An important element in the debate surrounding aging and society has been the notion of independence and the supports required by the elderly to remain in control of their own lives, as long as possible. A number of communication devices have been developed utilizing conventional telephone and personal computer technology, to respond to these issues.

The systems reviewed in this study, broadly known as "emergency response systems" provide the means to summon help when a medical, personal safety, fire or other environmental emergency happens to an elderly person. The focus in this study is on an organized system of emergency response that utilizes remote control devices and telephone lines to signal emergencies. This study describes, reviews and analyzes the existing and future role of such emergency response systems for the elderly in Canada.

This study is particularly concerned with the ability of telephone emergency response systems to contribute to providing the elderly with the choice to remain independently in their homes and to reduce the costs of publicly provided housing and care for the elderly.

Typical system configurations of emergency response systems are described, in terms of both product hardware and monitoring services.

A review of available emergency systems was combined with detailed interviews with industry representatives, and geriatric practitioners. In addition, limited interviews with emergency response

system users were done, where possible. An extensive literature review in conjuction with the original research, resulted in a list of product (hardware) and program criteria.

Hardware criteria are presented under the headings of: system activation; monitoring; priority; verification; portability; operating range; reliability; universality; and impact on personal privacy.

Criteria for emergency response system programs concerned with delivery of the service are covered under: program development; monitoring; user support; affordability; and servicing.

The cost-benefit analysis comparing in-home emergency response systems to institutionalization is complicated by a multiplicity of factors. In particular, any cost/benefit analysis would have to consider a large number of qualitative costs and benefits difficult to "quantify". However, the research appears to indicate real benefits in such areas as:

(i) reductions in costs for institutionalization;
(ii) reduction of anxiety by both the elderly and their families and;
(iii) immediate response to emergency situations.

Improvements to emergency response systems currently available are recommended, such as the need to eliminate wearing or carrying an alarm activator (transmitter). Voice activated telephones suggest an alternative that should be tested. Remote two-way communication between user and monitoring centre should also be considered and tested as a standard feature.

The emergency response system could also include an internal warning system that notifies users and the monitoring centre when

they have left their oven on for too long, or smoke or fire is detected.

Another major area of improvement is in system delivery. Delivery of emergency response systems could be more widespread, and integrated more closely with other home-based services that contribute to the elderly being able to remain at home.

Emergency response systems may also be tested for use with "homing devices" which enable emergency responders to locate the elderly person when they are beyond the operating range of the base station in their home. If elderly users are receptive to using such homing devices when they are away from home, their individual mobility is greatly increased.

The study concludes with the recommendation to develop a Canadian hardware and service package that incorporates the strengths of existing systems and the innovations discussed above. This refined and improved emergency response system should be implemented and monitored as a demonstration project in Canada in order to test the suitability of emergency response system within the context of Canadian home and community support systems for the elderly.

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Introduction

1. INTRODUCTION

1.1 THE ROLE OF EMERGENCY RESPONSE SYSTEMS

Emergency response systems provide the means to summon help when a medical, personal safety, fire or other environmental emergency happens to someone who does not have the individual ability to cope.

This report examines the use and development of emergency response systems that assist the elderly to live independently in their homes. The focus on the elderly is a result of three factors. First of all, there is strong evidence indicating that the population aged 65 years and over in Canada will increase significantly in the next decades[1]. In light of this growing population, all levels of government are actively seeking alternative cost-effective support systems that will enable an aging population to live independently, as long as possible, in their own homes[2].

Secondly, there is a growing concern that the elderly are at high risk with respect to incidence of emergencies, particularly health-related emergencies. There are concerns that reduced mobility, functional disabilities and infrequent contact with other people result in the elderly not receiving the immediate care they need.

Policy makers are not only concerned that elderly people may be unattended in an emergency, but also that poor responses to emergency situations often resulted in extended institutionalization.

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1 Between 1986 and 2006 a 52% increase in the population aged 65 and over is projected by Statistics Canada. See The Seniors Boom, 1986.

2 François Béland cites 15 different studies concerned with services and care available for the elderly at home as an indicator of "evidence of the importance accorded the idea of keeping people in their own homes and the search for alternatives to institutionalization". "The Decision of Elderly Persons to Leave Their Homes", The Gerontologist, Vol. 24, No. 2, 1984.

Finally, there is evidence that the growing numbers of older Canadians increasingly seek alternative living arrangements to minimize the potential risk of emergencies. Seniors who live alone now consider looking for people with whom to share their home, or they may enter a congregate facility or long term nursing care home for the elderly. The impact on government housing agencies is an increasing demand for housing with support services.

There are two major reasons why a program of increased institutionalization for elderly is unsatisfactory: These include:

i) cost; and,
ii) the growing realization that such a response is contrary to the wishes of a majority of the elderly.

The implications of the cost of institutional accommodation for the elderly is significant. Research in Newfoundland, Manitoba and Saskatchewan shows that institutional care costs seven to nine times more than care provided in the home.[3] A recent Canadian Medical Association Task Force highlighted the increasing costs of care for the aged and advocated an emphasis on the provision of alternative independent and supportive living situations for the elderly.[4] For those who are able to live outside an institutional setting, cost is a compelling factor.

The literature on the support needs and housing choices of the elderly clearly shows that in Canada, seniors prefer to live independently in their own private homes. The National Advisory Council on Aging expresses it succinctly:

> The primary interest of seniors is to continue to live autonomously in the community and preferably in their own homes.[5]

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3 Expression, Vol. 3, No. 2, Spring 1986, pg. 2.

4 Canadian Medical Association. Health - A Need for Redirection, 1984.

5 National Advisory Council on Aging. Toward a Community Support Policy for Canadians, January 1986.

The homes that seniors live in are as varied as for any other age group. In 1981, 90% of Canadian women aged 65 years and over and 93% of men in this age group lived in private households. Of these two groups, approximately 60% lived in single family houses. Approximately 12% lived in high rise apartments (5 or more stories high), and the remaining 28% lived in other types of multiple dwellings.[6] Emergency response systems must, therefore, be appropriate for single family houses, duplexes and townhouses, and apartments of all types, as well as for those who live in housing projects offering a range of medical, social and personal services.

Emergency response systems must also be sensitive to geographic location. Rural, suburban and urban locations all impose different challenges for an emergency response system. It is with these challenges in mind that the national study of the role of emergency response systems for the elderly was undertaken.

1.2 OBJECTIVES OF THE STUDY OF EMERGENCY RESPONSE SYSTEMS

This report constitutes the final stage of a comprehensive description, review and analysis of the existing and future role of emergency response systems for the elderly in Canada. Canada Mortgage and Housing Corporation contracted consultants to undertake a national study of emergency response systems for the elderly. The main objectives of this study, as outlined in the Terms of Reference, are to:

- o determine the potential of emergency response systems to help elderly people maintain independent lifestyles in the community, thereby reducing the demand for institutional care;

- o develop system designs and specifications for effective emergency response systems and related support service organizations; and

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6 Statistics Canada. The Elderly in Canada, April 1984.

- o identify opportunities for the development and application of new technology and organizational structures that could improve the cost/benefits of emergency response systems and support services, particularly in comparison to institutional care.

1.3 STUDY APPROACH

In order to analyze the role of emergency response systems (ERS) for Canada's elderly population, the study was divided into several tasks. First of all, a detailed inventory and classification of existing emergency response systems available in Canada was produced.

Secondly, interviews with elderly people currently using an emergency response system, and with practitioners specializing in geriatric support and services, were conducted. The purpose of these interviews was to examine the needs of elderly people with respect to emergency response.

The third task involved a review of emergency response systems in light of both costs and benefits to the elderly user, the users family, the long term care, home care and hospital systems and generally to society at large. In addition, the order of magnitude of demand for emergency response systems was considered. At this stage a workshop was held to review and discuss study findings.[7] Following the workshop, the consultants began identifying new service structures and delivery mechanisms, as well as new technologies that have the potential to improve the effectiveness of emergency response systems in Canada.

The final task involved a complete review of the data collected in order to develop criteria for emergency response systems and to identify opportunities for research and development that can continue to improve emergency response systems in Canada.

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[7] Workshop Materials are found in Appendix 1.

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Types of Emergency Response Systems

2. TYPES OF EMERGENCY RESPONSE SYSTEMS

Emergency response systems span a wide range of technical and organizational complexity. The most basic form of emergency response system is the call for help, in hopes that other residents in the house, or neighbors will come to provide aid. A slightly more sophisticated system is to use the telephone to dial family or friends or a "911" emergency number. These types of systems rely heavily on the ability of the person in distress to call out or reach a telephone and dial it. In many cases the circumstances of the emergency (for example, if the person is unconscious), or the lack of anyone to hear the call for help, prevent an immediate response.

This report focuses on organized electronic systems of emergency response with a particular emphasis on systems that have a remote control that utilizes telephone lines to signal an emergency.

2.1 SOCIAL MONITORING SYSTEMS

While this study is limited to electronic emergency response systems, there are many other systems that the elderly can use to prompt response to an emergency situation. They tend to be characterized by lower levels of technology and less formal organization. Examples of emergency response systems characterized as social monitoring systems are described below.

- Postal Alert: In many communities across Canada letter carriers have volunteered to notify authorities if they notice anything amiss in the course of their daily postal delivery. Elderly people register with their local letter carrier depot and the letter carrier keeps track of those who depend on this check.

People wishing to participate fill in a form listing their name and address along with telephone numbers of three emergency contacts. Letter carriers who notice signs that someone may be in trouble, such as mail piling up, contact an alert centre where data on the participant is filed. Volunteers at the alert centre investigate the situation and arrange assistance if required.

This system is primarily for those who live in single family houses. Seniors on rural routes, who receive their mail at post boxes or suburban "superboxes", or who live in apartment buildings with a central mail room cannot be served under this program.

Another problem with this approach is the frequency of the check. During the week the check is only once a day. Obviously there are long periods over weekends and holidays when no service is provided. The main advantage of this system is cost - it is run on a volunteer basis with no charge to the senior.

- o Card System: In housing developments with large concentrations of senior citizens, residents sometimes organize to do a daily check. Each day by a set time, the senior resident slips a card under their door into the hallway of the building to indicate that they are up and well. The card is visible to a volunteer who patrols the halls and investigates if a card has not been put out.

The major advantages of this system is ease of organization and minimal cost. The disadvantages are the frequency of the check (usually once a day), and the fact that this system really only works for multiple-unit buildings with a large number of seniors.

- Buddy System: Another volunteer system is a telephone buddy system. Each day a volunteer telephones a senior citizen with whom they have been paired to ensure that the senior citizen is able to answer the telephone, and is well. In Ontario, provincially funded homes for the aged often have a Telephone Alert Program (TAP) staffed by residents and other volunteers. Elderly persons who live in the community may be called one or more times a day. Often a second line is provided for incoming messages.

  Similar to the card system, cost is the main advantage. It is also easily implemented regardless of house type or location. However, this system has the added social benefit of daily conversation with another person. The disadvantage, once again, is the frequency of the check. For example, the daily check may be too late for someone injured hours before the next telephone call can be expected.

2.2 ELECTRONIC MONITORING SYSTEMS

Currently in Canada, there are two major types of electronic monitoring systems. They are described below.

- Hard-Wired Alarm Systems: Hard-wired alarm systems are systems actually built into a dwelling unit. The telecommunications lines that link the apartment to the monitoring centre are, therefore, separate from the telephone system. In most cases an emergency call button is located in the bedroom and the bathroom (where it is assumed most emergencies occur). When activated, an alarm is sent to a monitoring centre in the building. Emergency calls can either be monitored in each building, or they can be forwarded by telephone to a central monitoring station. Some hardware systems are either exclusively non-activity systems or are a combined non-activity/active emergency alert system.

Non-activity systems alert a monitoring centre when a person fails to undertake an expected daily activity. For example, the Metropolitan Toronto Housing Company has a Housing Health Alert Program (HHAP). Each housing unit has an infrared detector positioned to cover normal traffic areas between bedroom, kitchen and bathroom. Each detector is wired to a central alarm monitoring panel in the superintendents office. Each time normal movement breaks the infrared beams the system recycles. If there has been no movement in the apartment for 16 hours, an alarm condition is registered at the main control panel.

The advantage of the hard-wired system is that it can be made easily available to a large number of seniors if incorporated into building plans prior to construction. The disadvantages of this system are numerous however.

First of all, it is only applicable in multiple-unit buildings such as apartment buildings. It is not accessible to the majority of seniors who live in different types of housing. Second, it is likely to be made available only in situations where nearly the whole building is occupied by senior citizens. Third, with the majority of systems currently available, the elderly person must be able to actually reach the emergency call button.[8] If an accident occurs in a room or part of a room other than those areas where the button is located, the senior may be physically unable to utilize it. Finally, issues of liability, cost (particularly in an apartment building with few seniors) and suitability of monitoring personnel frequently arise.

Possible improvements to the hardwire system and the special role of hard-wired systems in multiple unit housing are discussed in Section 10.

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8 It should be noted that some hard-wired systems can be activated by a remote transmitter.

- Telephone Monitoring Systems: Telephone monitoring systems rely on telephone lines which are coded to dial the telephone number of a person or centre that has agreed to receive emergency calls.

  A remote control device can be used to activate the automatic dialer. This technology means that the person does not have to be near a telephone or remember emergency telephone numbers. It is not dependent on dwelling type and will function in any type of house. Since it operates on a telephone line, it is feasible for any geographic location that has telephone service.

  Emergency calls received through telephone systems are either monitored through a central monitoring station, or they are stand alone systems where the response system user individually arranges monitoring with friends, family or agencies of their choice.

  Telephone emergency response systems have been designed to alleviate many of the problems of the systems described in all the above emergency response systems. The rest of this report concentrates on telephone emergency response systems available in Canada in late 1986.

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Telephone Emergency Response Systems

3. TELEPHONE EMERGENCY RESPONSE SYSTEMS

3.1 TELEPHONE EMERGENCY RESPONSE SYSTEM HARDWARE[9]

o Basic System Configuration

System configuration described here is a typical one and covers a great majority (90%) of the systems surveyed. Deviations from this predominant pattern are outlined in section "Alternative System Configurations".

The hardware or products of a typical emergency response system consists of:

a) a portable transmitter;
b) a base station;
c) a telephone link; and
d) a central monitoring station.

A typical configuration is shown on Figure 1. The remote control device is a portable transmitter which a user wears or carries. This technology means that the person does not have to be near a telephone or remember emergency telephone numbers. The transmitter is effective within a certain radius (R) from the base station located at the user's home. The products available in Canada offered operating ranges of 45 to 200 meters.

The base station, a receiver/transmitter, communicates with the central monitoring station over a telephone line. The central monitoring station, in addition to hardware components (which may include computers, telephone, video monitor, printer), has an operator on duty on a 24 hour basis.

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[9] A list of products reviewed for this section is found in Appendix 2.

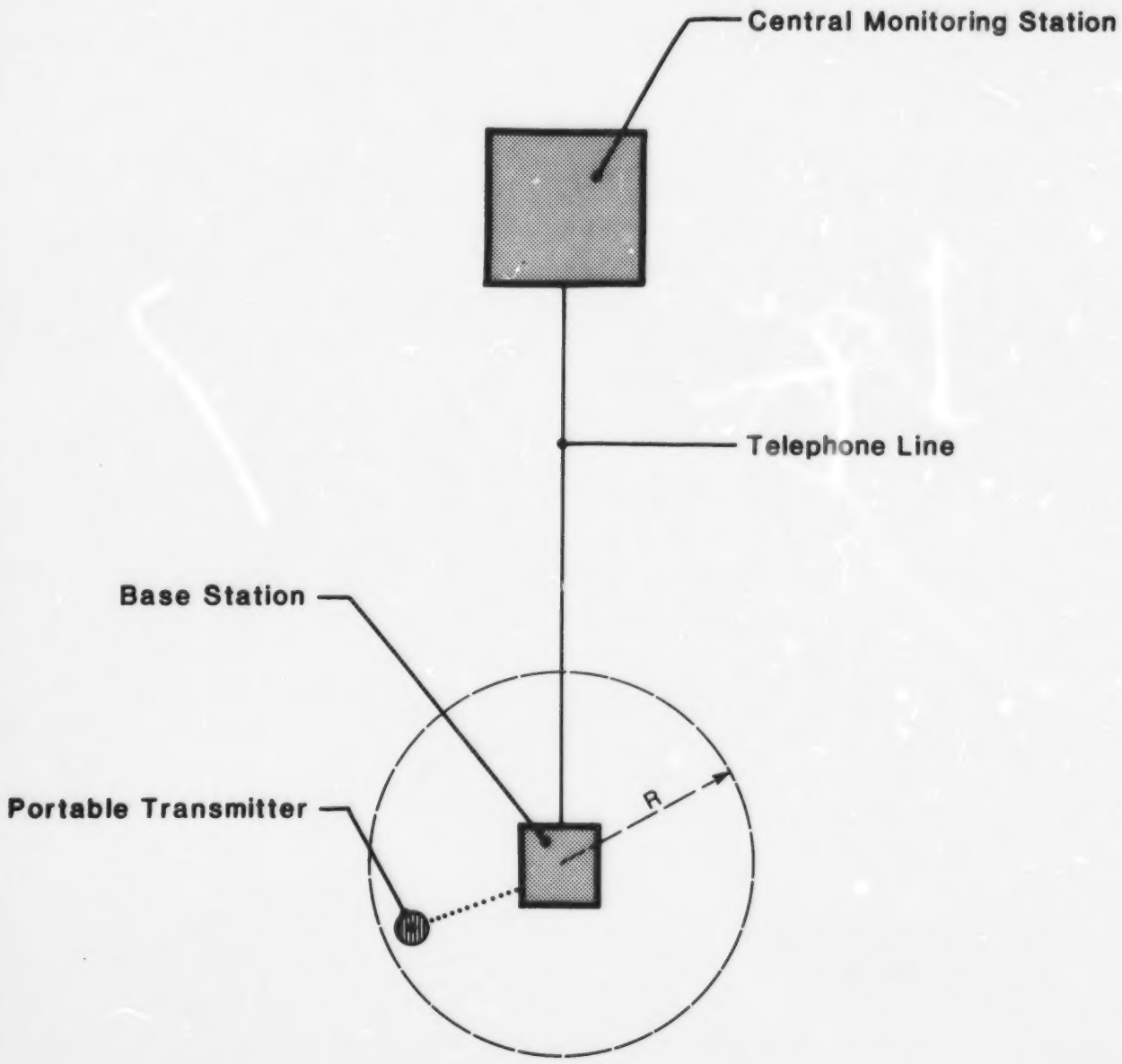

Figure 1.

Wireless Emergency Response System

Typical configuration of monitored system

o Description of Operation

An emergency response central station is "the brain" of the system and is constantly "listening" for an emergency signal from any of the base stations connected to the system. A user in need of help initiates an emergency call by activating their portable radio transmitter. The transmitter starts emitting a series of digitally coded radio signals, which, providing the user is within the operating range, are received and decoded by the base station. The base station then "seizes" the phone line, automatically dials the central station and sends it a digitally coded message[10]. The operator at the central station first tries to establish the nature of the emergency (medical, fire, burglary, etc.) by dialing the user's phone number. If this attempt fails, the operator proceeds by following a procedure established with the user at the time they receive their system. The necessary contact procedures are displayed on the video monitor and/or computer printout, or retrieved from the client file (usually a card index system). An appropriate help team is dispatched when the contact procedures have confirmed an emergency situation.

Some systems have additional emergency buttons on the base station which allow the user to define more effectively the type of emergency, thereby reducing the system's response time and eliminating potential false alarms. However, these buttons must be activated manually at the base station. At the time of this study, no system in Canada, designed for use by the elderly, allowed the user to define the type of emergency with the remote transmitter. The three buttons have to be small to fit on the portable transmitter and are difficult for the elderly to use.

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10 It should be noted that if the elderly person shares a party line, as may be common in rural areas, the emergency code will not be transmitted if another party is using the telephone.

1.

This system has additional buttons to indicate fire, health or related emergencies.

Some products have both a remote control transmitter and a timer initiated non-activity system, where the system is also activated by the failure of the user to regularly use the system as prescribed within a preset period of time. For example, if the user does not push a reset button at least once every eight hours, the response centre investigates to see what has prevented the user from doing so.

o Alternative System Configurations

A major departure in terms of system configuration from the typical one described earlier is a system without a central monitoring station. With this stand alone system, the base station is programmed to dial up to four preselected telephone numbers in order of priority. Selected "responders" (e.g. relatives, friends) receive a pre-taped voice message when the system is activated and follow certain procedures, similar to the central station operator's, in order to establish and dispatch the type of help needed (see Figure 2).

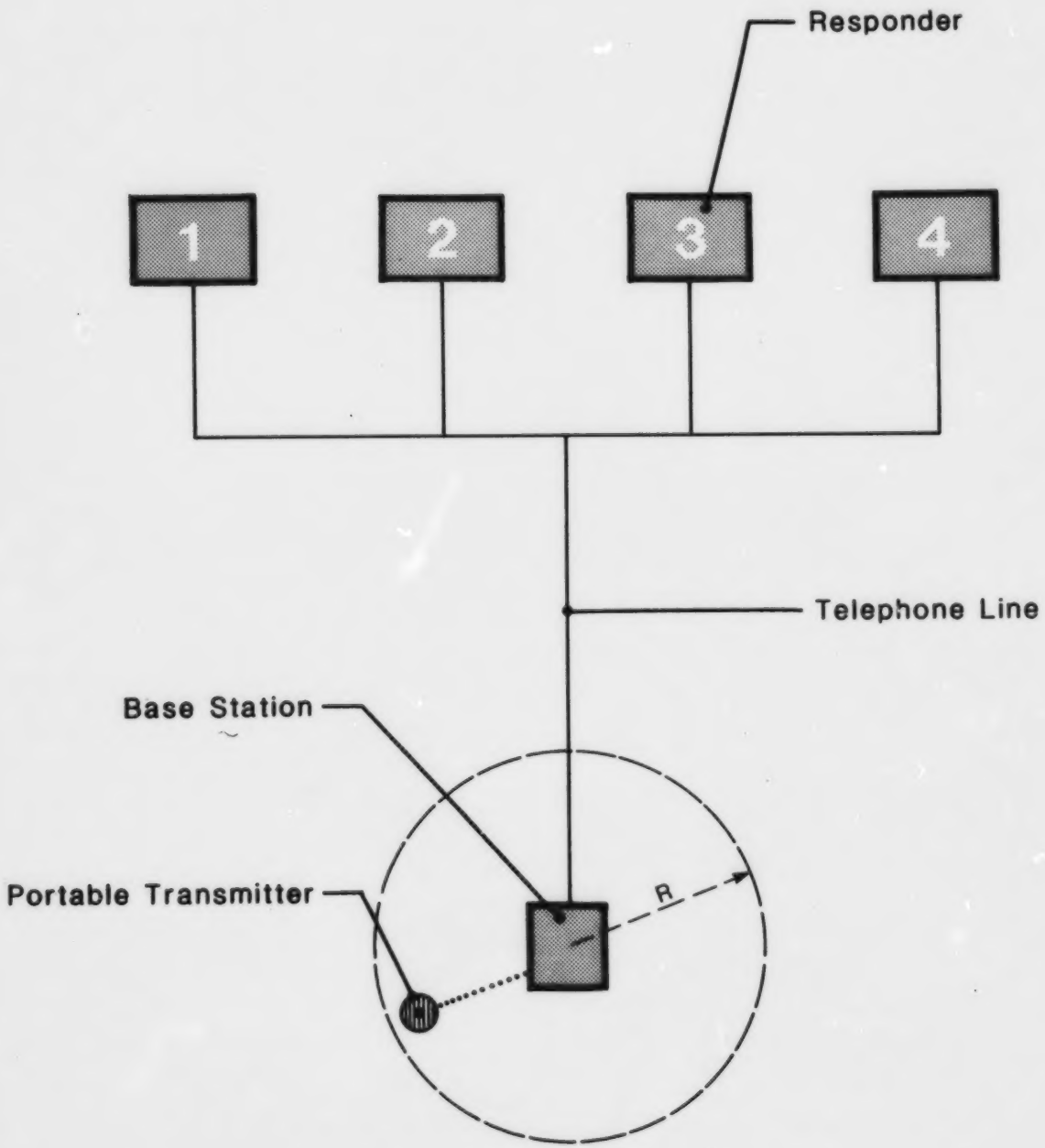


Figure 2.

Wireless Emergency Response System

Typical configuration of stand alone system

- System Component Characteristics and Variations

  - Portable Transmitter: The following are characteristics common to all transmitters studied:

    - portability;
    - digitally coded radio signal;
    - D.C. (battery) powered;
    - limited operating range;
    - pressure/force activated; and
    - 100% solid state components.

    A number of the above characteristics vary from one emergency response system to another. For example, the coding algorithms are different and often selectable. Battery operating life is usually quoted as 6-12 months, but it can be as high as 5 years. Most systems fall within 50 - 60 metres operating range, but again, there are a few exceptions. Although all transmitters have some sort of a button actuator, most are equipped with a single button, whereas others have two buttons. The "two buttons" alternative apparently reduces the possibility of false alarms, but may be problematic to some elderly users if, for example, they have manual dexterity difficulties. Some transmitters are water resistant which is useful in case users forget to remove the transmitter when washing or bathing.

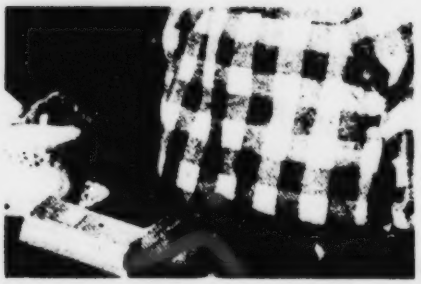
    From the technical point of view transmitters differ in the following aspects:

    - shape (round, rectangular);
    - size;
    - how carried (pendant, wrist, pocket); and
    - weight.

These characteristics play a definitive role in the emergency response system selection process when meeting the users perception of convenience and taste. Economic feasibility and user safety must, of course, be considered in the design of transmitters.

2.

3.



4.

Example of Portable Transmitters

- o <u>Base Station</u>: Base stations too have a number of common characteristics:

  - o contain decoder and dialer;
  - o powered through an A.C. adapter;
  - o power back-up (rechargeable battery);
  - o "TEST" and "RESET" buttons;
  - o use of a telephone line (dial or touch-tone);
  - o audible and/or visual transmission indicator; and
  - o Erasable, programmable memory (EEPROM)

There are small variations between systems regarding these common features. For example, rechargeable batteries usually provide power back-up for 3-5 hours, but, in some cases this period extends to several days. Successful transmission is usually indicated by a change in tone (buzzer) or by extinguishing a blinking light.

Features available as an option or pre-packaged with some base stations include:

- o additional emergency buttons (police, fire);
- o "HOME/AWAY" switch;
- o inactivity reporting;
- o continuous self-check; and
- o periodic, regular unit check.

Some systems, have the "home/away" switch and the "inactivity reporting" built-in as a result of their operating philosophy. The user is supposed to report to the central station once in 24 hours. If that does not happen, the base station automatically initiates an emergency call at the end of the 24 hour cycle. To avoid false alarms, when the user is away from home, the "home/away" switch is used. In the "away" position this switch disables automatic inactivity reporting. Once the user is back at home, flipping the switch to "home" position resets the timer and starts the reporting cycle again.

The idea behind the automatic inactivity reporting is to cover, to some extent, cases in which a user in need of help, didn't manage to activate the emergency response system. However, the probability of false alarms increases with this type of a system.

The automatic line "seizure" allows the base station to forward an emergency call even with the telephone receiver off the hook. Voice communication in progress gets interrupted, the line is seized and a message sent to the central station. By acknowledging the call the operator at the central station resets the system.

Continuous base station self check is another built-in feature of some systems. A continuous diagnostic routine monitors the unit and reports "unit trouble" with an indicating light. In addition, some systems continuously monitor and report on the status of the telephone line. Continuous telephone line monitoring requires a dedicated telephone line which may increase the cost of monitoring the system. Most emergency response system suppliers offer either a mandatory or an optional periodic system check at regular intervals, which is performed from the central station end.

- Central Station: In technical terms there are some essential differences between central stations depending on whether they are equipped with computers, tape recorders, video monitors and printers in addition to telephone lines. Additional equipment, back-up phone lines or operators, serve to increase system reliability, but their number does not alter the basic operating principle or the features systems offer to their users.

5. An example of a central station monitoring

The computer(s) provide an easy access to the data base which contains essential personal information for every service subscriber, list of institutions and persons to be contacted in case of emergency. The video monitor and printer provide, respectively, the "image" and the hard copy of the data base content.

Simple central monitoring stations consist of telephone lines and a card index system which is used to manually retrieve information about the instigator of an emergency call.

o System Dependability

The system dependability (a level of confidence) is a function of a number of key components. These include:

- o operational readiness;
- o accuracy and selectivity;
- o degree of redundancy;
- o simplicity of operating procedures; and
- o monitoring on a 24 hour basis.

The operational readiness is the readiness of the whole system to respond to an emergency. The nature of the station (emergency monitoring on a 24 hour basis), and the expected level of preventive and corrective maintenance it is likely to receive, imply a very high degree of readiness for this system component.

The telephone link has its level of reliability totally independent of the emergency response system. However, it can be stated in very general terms that the telephone link reliability decreases with its distance and the number of switching stations involved.

Readiness at the user's end (the base station and the transmitter) is easily checked by switching the system to "TEST" mode and performing the test. Doing this test even on a weekly basis would ensure a high degree of user confidence, as well as increasing the readiness probability for this part of the emergency response system. A number of systems stop at recommending the user to do a periodic test, others have a scheduled test in their operating procedures. Some perform tests on a daily basis as a result of their systems operating philosophy. Systems with continuous monitoring of the transmitter, base station and the telephone line ensures a high degree of readiness for that portion of the system.

In case of a prolonged power outage, (over 3 hours), the system's readiness becomes dependent on the capacity of the base station's rechargeable battery. It is assumed that central stations are equipped with an uninterrupted power supply of ample capacity.

The accuracy is mentioned more as a theoretical than a real concern in an emergency response system. The base station is adjusted to a certain transmitter's carrier frequency and it is important that, over a period of time, the transmitter does not introduce any frequency drift. The use of crystal controlled oscillators in transmitters assures an accurate carrier frequency at all times.

The base station, being in part a radio signal receiver, could be activated by an external radio signal such as a garage door opener and produce a false alarm. The selectivity in this context is the ability of the system (the base station) to "screen" the incoming radio signals, falling within a certain frequency band, and distinguish a real alarm from a false one. Most base stations react to a signal which has a distinct pattern, (digitally coded), and is repeated in succession several, (usually four), times.

These criteria, when applied, produce a high degree of system selectivity.

The Federal Department of Communications does not currently licence transmitters in Canada. Therefore, it is not possible to exercise control over a specific frequency. In addition, not all base stations operate in the same frequency range. Those at lower, commonly used frequencies are more susceptible to interference from other remote controlled devices, such as garage door openers previously mentioned. Some base stations are designed to operate at higher frequencies and may have less chance of interference. Higher frequencies also serve to increase the distance possible between the remote transmitter and the base station.

Redundancy, in practical terms, is a duplication of system components, a provision of "stand-by" spares. When an active component fails, the "stand-by" assumes its role and the system continues to function. Usually, only the most critical system components have a stand-by spare (i.e. computers in the central monitoring station). Most emergency response systems offer some degree of system redundancy at the central station end. More than one incoming phone line is another example of a system component redundancy. To ensure a high level of dependability, a system will have three or four telephone lines. A 100% system redundancy is usually not offered, nor is it required.

The simplicity of operating procedures is yet another element influencing dependability. All systems with the central station have a very simple procedure. On the other hand, systems without a central station, have to have a more complicated control algorithm for the base station, in order to cover all possible circumstances (one or more selected "responders" not at home).

Continuous, 24 hour monitoring at the receiving end of the emergency call has an important psychological, as well as a practical, value to the system dependability.

3.2 TELEPHONE EMERGENCY RESPONSE SYSTEMS: MONITORING

The monitoring service is an important component of the whole emergency response system. The nature and quality of monitoring determines the speed of the response to an emergency call and the appropriateness of the response.

Moreover, the nature of the monitoring service plays a major role in assisting the elderly to understand how to use the system and to provide guidance to minimize false alarms.

Emergency calls received through telephone emergency response systems are either monitored through a central monitoring station or they are stand alone systems.

3.2.1 Centrally Monitored System

The first type of remote system is a centrally monitored system which, when activated, sends an encoded message to a central emergency response centre where it is interpreted by a computer or answered by centre staff.

With the monitored system, all emergency calls are received by an emergency response centre. Calls can be monitored either locally or at a regional or national office. Local monitoring of emergency calls is frequently handled by a hospital which is already established as a 24 hour emergency centre. Some emergency response system operators establish a central office and monitor all calls from across the country at one location.

An important feature of centrally monitored systems is the link between equipment and the operation of an emergency response centre. Some companies sell monitoring equipment to hospitals and community agencies and train these organizations to monitor calls and administer emergency response programs. Another variation is companies which offer answering services and monitoring for a wide variety of users, including emergency response system products. The monitoring or service side of the system can be a separate business from the product or technological device side.

The system is vulnerable when service or monitoring responsibilities are separate from product maintenance and use. As a response to this, some companies provide emergency response equipment and link it to their own monitoring service. In practice, however, research conducted for this study found that monitoring agencies received detailed training and continuous support from manufacturers and that monitoring agencies assumed many of the responsibilities for ensuring that elderly users were properly instructed in the use and care of their system.

Centrally monitored systems available in Canada fall into three categories:

o Security Company - National/Regional Monitoring.

  There are several private Canadian security companies that offer a medical alarm service among a range of other comprehensive alarm services such as fire and burglar detection. These companies generally monitor emergency calls for a large geographic area from one location. Even if distributors are local, the monitoring is still done by national or regional office using long distance telephone lines and service.

o Security Company - Local Monitoring.

Many private security companies distribute their products and arrange monitoring services locally. Again, the medical alarm is often an added feature to a comprehensive home security system that includes fire and burglar alarms, although local companies are becoming increasingly involved in 'exclusive' medical alarm systems.

o Systems Monitored by Social Service Agencies.

Some emergency response system distributors sell their hardware to social service agencies which establish a monitoring service. Distributors often provide more than the home units and monitoring equipment. They also provide materials to market the system and operating guidance. They follow-up on both the system, and monitoring procedures, to ensure that system standards are met.

3.2.2 Stand Alone Systems

The second major type of telephone emergency response system is the stand alone system. The stand alone system is not linked to a designated response centre, rather, the system when activated (either by remote dial or timer-activated as with the centrally monitored system) is programmed to dial telephone numbers that the user chooses. The user must ensure that they have chosen respondents who will be able to react to an emergency situation at any time.

Activating the emergency system results in a voice or voice simulated message being sent sequentially to the telephone numbers on the program. Usually this message is programmable only by a manufacturers representative.

3.2.3 Review of Canadian Emergency Response System Monitoring

Over 70 different Canadian monitoring companies and agencies were contacted and interviewed. Some limitations to the survey should be noted[11].

First of all, many respondents were unable to provide factual data. Therefore, many of the questions were answered using estimates[12]. Many programs have not been established long enough or do not have the resources to collect detailed data on their program.

Secondly, when security companies were interviewed, the information received was very sketchy. These companies are 'selling' security and they are reluctant to provide any information that threatens the confidentiality or the well-being of their customers.

Thirdly, emergency response systems are being installed daily, so the data only reflects the point in time at which it was collected[13].

Finally, there was not the time or resources to talk to every local security company across Canada, so only major distributors and monitoring companies have been identified.

The results of the review are documented under the four categories of monitoring systems.

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11 Companies and agencies that were contacted are listed in Appendix 3.

12 Once the data was tabulated and averaged the results proved comparable to other studies.

13 Data was collected during July 1986.

o The "Stand Alone" or Independent System

This system is most often purchased by an individual (or family of an elderly person). However, there are several examples of hospitals and other non-profit organizations purchasing the systems and lending or renting them to their clients. A 24 hour service is only guaranteed if an organization such as a hospital, acts as a respondent and provides personnel to monitor the calls on a 24 hour basis.

The user profile of "a stand alone" system is comparable to that for other system types except that the proportion of functionally impaired users with potential for institutionalization appears, in findings to date, to be higher. This is possibly due to the fact that the expense of the system demands that only those who really need it acquire the service. Also, it was found that the health care organizations who have purchased this system did so to aid patient discharge planning and to assist those on long term care waiting lists.

With the "stand alone" system, a response or central monitoring centre is not required as calls go directly to emergency responders. However a programmer is usually required to code the machine. If a user wishes to change one of the pre-approved respondents there can be an extra charge for recoding telephone numbers.

Another feature of the "stand alone" system is that it requires responders to have a touch tone dialer or at least a touch tone 9 to indicate to the coded machine that the voice chip need not continue to repeat the coded message.

A key advantage of the "stand alone" system is that it is portable. Since it is not tied to any particular monitoring service, the user may take the stand alone unit anywhere there

is telephone service. It should be noted that when the stand alone system is moved an expert system representative must be called upon to re-make the voice message that notifies respondents of an emergency. The user must also assume the responsibility for notifying respondents of new locations so that emergency help will arrive at the correct address.

A problem with stand alone systems is that regardless of whether respondent 1 or 2 is reached, 3 and 4 are also called and have no way of knowing whether or not the user has been assisted. Furthermore, the telephone system is tied up, so that emergency responders must go to the senior's home to determine what has happened. This potential inconvenience must be weighed against the advantage of having two or three extra people responding to an emergency situation.

o Security Company - National Monitoring Systems

These systems differ from other monitored systems largely in their scale of operation. Security systems have more users than all other system types together. Each company within this category has one monitoring station that will monitor calls across Eastern or Western Canada.

Although the cost of subscribing to such a system is comparable to systems monitored by non-profit organizations, the personal level of service is less well developed. Subscribers are generally visited only once for the initial system installation. Users are not monitored with regard to the appropriateness of the system for their situation or in relation to other home support services that could assist them. However, security companies do telephone and test the systems periodically.

The findings of the monitoring survey indicated that the national monitoring security companies received less emergency calls per user than did the other monitored types. This difference could be partially explained by the low percentage of functionally impaired users and by the fact that subscribers are coached to only use the system when there is a serious emergency. When the system is monitored by a non-profit organization there is a less formal approach to the system's use. The non-profit organizations always telephone subscribers first, then send respondents before dispatching an ambulance and police car. This is not necessarily the case for national security companies. Consequently, an error call with a security company system could be more costly than an error call with a non-profit monitoring system.

An advantage of central monitoring done at the national or regional scale is the potential portability of the system. A system that uses an "800" toll-free number for monitoring can be totally portable. The central monitoring station need only be informed about the new location of the emergency response system user and any change in their emergency needs.

o Security Company - Local Monitoring System

These systems are very similar to the national security company monitoring systems but are monitored locally and operate at a smaller scale. It is very difficult to get user profile data due to the confidentiality of the security business. Key informant interviews suggest that the user profile is comparable to the other system types except that the users of this system probably have higher incomes. The users of these systems tend to add on a medical alert alarm to a previously purchased burglar and fire alarm system and are interested in complete home security systems. However, many local security companies are beginning to market alarms developed specifically for medical use.

These companies are generally not interested in expanding the service area they monitor in each community because they believe they can provide a more efficient service by monitoring locally. The advantages of local monitoring are:

i) users are likely to feel more confidence in a locally based service;
ii) local emergency handlers are more responsive and able to adapt to local conditions.

o Systems Monitored by Social Service Agencies

The majority of social service agency monitoring services are offered through hospitals. Hospitals have found that emergency response systems play an important role in discharge planning. With an emergency response system elderly patients can be sent home earlier than possible if they had no direct emergency communication with the hospitals.

Other social service agency monitoring services tend to be located in existing facilities for the elderly such as a long term care facility. Here, emergency response systems are used as a community service to provide those who are not in care with easy access to emergency aid. One community group established a monitoring centre at a local motel which has 24 hour reception.

Monitoring offered by social service agencies tends to include frequent personal contact with, and support for, users. However, because social service agencies have their own operational goals and limited resources, they develop criteria for eligibility in the program. Therefore, they target their system to the users they consider eligible.

The first major problem of all monitoring systems reviewed is that they are not accessible to all elderly because of:

i) cost; or
ii) eligibility criteria.

The second major problem of current monitoring services is that they are not well linked to other home support services the elderly receive, as they are primarily provided on a commercial basis, or to achieve specific goals of particular institutions or agencies (such as reducing hospital bed utilization).

A third problem is that monitoring agencies have to deal with the issue of liability. The costs of liability insurance could become onerous to both the monitoring agency and those paying for emergency response system services. Ways to waiver liability or pool resources to reduce the cost of such insurance may be necessary.

THE STUDY OF
EMERGENCY RESPONSE SYSTEMS FOR THE ELDERLY

Qualitative Assessment

4. QUALITATIVE ASSESSMENT OF EMERGENCY RESPONSE SYSTEMS: ELDERLY USERS; PRACTITIONERS AND SUPPORT PROVIDERS

An important component of the assessment of emergency response systems were interviews with elderly persons who currently use an emergency response system[14]. In addition, health care and service support practitioners were interviewed to gain their perspective on the role of emergency response systems for the elderly[15].

4.1 INTERVIEWS WITH EMERGENCY RESPONSE SYSTEM USERS

Companies and organizations that monitor emergency response systems were asked to supply the consultant with a list of names of users. Once a complete list was compiled, a structured sample would be chosen based on product and user characteristics such as degree of medical vulnerability. The interviews were to be conducted in the Vancouver area.

All identified emergency response systems in the Vancouver area at the time of the survey[16], were monitored by private security companies. Security and confidentiality are trademarks of these companies and most refused to disclose the names of their clients. In cases where security was not an issue, monitoring company representatives wished to 'protect' their clients due to perceived limits imposed by age and health.

An opportunity became available to undertake interviews in southern Ontario. Several hospital based emergency response systems, and a national and a local monitoring company made names available and 23 in-depth interviews were conducted.

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14 The questionnaire used is in Appendix 4.

15 For a list of people interviewed, see Appendix 5.

16 July 1986.

The objectives of the interviews were to:

1. Develop a profile of users; age, sex, reason for use, degree of frailty, etc.;

2. Document the user's evaluation of the system;

3. Identify problems that the elderly encounter with hardware and technology, monitoring, and response;

4. Determine if the elderly feel more secure and independent while using an emergency response system;

5. Discuss: one, alternative living arrangements if the emergency response system was not available; and two, other support systems necessary to help users remain in their homes.

The results of the survey are discussed below.

o Profile of Users

Almost half of those surveyed made the decision to use an emergency response system on the recommendation of a health professional. Generally, an emergency response system was recommended due to a recent fall or due to a recent hospital discharge. If a health professional didn't refer the senior to an emergency response system program, family or friends did. Only two users decided for themselves that they needed an emergency response system.

Of the 23 users, 70% plan to keep their emergency response system and remain living in their homes, and 13% plan to keep it until they recover from a present illness. 17% planned to discontinue the service because of a change in living situ-

ation. One respondent was moving into the hospital, two were moving into a seniors home and one into a daughter's home.

The majority of those interviewed were female (83%) and were over 75 years of age (83%). 91% of the respondents lived alone, 86% have lived more than 5 years in their present home and 43% had lived more than 20 years in their present home. Half of the respondents owned their own homes, the rest rented apartments. Two seniors lived in seniors housing and two lived with family members.

o User Evaluation of Emergency Response Systems

The majority of those surveyed have had their emergency response system for more than one year and less than three years. Only 57% of those surveyed had activated an emergency call in the last year. This group generated approximately 20 emergency calls for health-related reasons, (most often due to falls) and a 8 calls due to error. All who had used the system for an emergency were very pleased with the response. All had their first return call in under 2 minutes (usually under 1 minute) and within 5 to 10 minutes they had help.

o Elderly Response to the Technology

All users found their emergency response systems easy to use. Many appreciated the reset button or check-in button that they were to use every 12 hours. Users also appreciated their monthly visits and the personnel approach of the program associated with hospitals. Seniors not using hospital based programs appreciated the friendly voices of the staff who phone them for test calls.

The maintenance and appearance of all systems was rated very high but the comfort of wearing the portable transmitter was

rated extremely low. Only 20% of the users actually wore the transmitter. They were found to be heavy, bulky and the chains were very irritating. Many seniors carried the transmitter in a pocket, placed it in a cover and pinned it to clothing or just kept it near them. The potential to forget the transmitter and to not have it when needed is therefore, extremely high.

- Security of Users

Every person interviewed praised the value of the emergency response system in providing them with security. Their comments included: 'It's like having a friend with you all the time', 'It's cheap insurance', 'I'd be in the morgue without it', 'It helps me remain in my home', etc. The elderly users were extremely appreciative of any device that helped them remain in their home. All of them felt more secure and comforted that help was near. Two users had returned home from a nursing home because they had an emergency response system (among other support services).

- Maintaining Independence

The majority of users felt that they are extremely independent and are determined to maintain that independence. 70% of the respondents stated that they would remain in their homes even if they didn't have the emergency response system. However, both they and their families would feel less secure if they did not have an emergency response system. 30% of the respondents felt that they would seek alternative accommodation if they did not have their system.

It is interesting to note that social contact did not decrease with emergency response system users. The demand on family support is high both before and after emergency response system

use. The role of informal and formal support networks in helping the elderly remain in their homes is, therefore, still very important. 70% of the users had extensive family contact and help. Just under half of them also used home care, or day care, and/or meals on wheels. For those without extensive family contacts, homemakers and nurses were considered very important.

The survey of 23 elderly users suggests that the following criteria be used in developing an emergency response system:

- Regular contact between emergency response system program operators and elderly users to facilitate acceptance and understanding of the system.

- The portable transmitter must be comfortable, and easy to wear. When the transmitter is heavy or uncomfortable users do not keep it nearby.

- Emergency response systems should be integrated into a program of other necessary support services that enable seniors to live in a non-institutional setting. Independence and the ability to live in their own home is facilitated by the use of emergency response systems.

4.2 GERIATRIC PRACTITIONER'S AND SUPPORT PROVIDERS ASSESSMENT

This section provides a review of interviews that were conducted with various practitioners and support providers who have expertise and experience working with elderly clients. Their opinions were sought to help understand some of the advantages and disadvantages of emergency response systems when evaluated in the larger context of a health care or home support service system.

All of the twenty-seven interviewed were familiar with emergency response systems. All informants, except one, felt that in general, emergency response systems for seniors were useful and worthwhile.

Those informants associated with hospitals were particularly interested in emergency response systems as an effective means of reducing hospital stay and allowing seniors to return home early. While they admitted that some senior patients (and the patients' families) experience anxiety and nervousness about returning home after a hospital stay, most elderly patients indicate a preference to return home as soon as possible. Informants felt an early return to home would be facilitated by the use of an emergency response system.

In addition to reducing hospital time for in-patients, emergency response is seen as playing an important role in serving those who have not yet required hospitalization. Accidents which occur in the night (particularly falls) when help is not readily available are a common occurrence. A device that brings early medical attention could reduce trauma for the elderly person and perhaps reduce the medical care required.

Some informants felt that the elderly generally have a barrier against "new-fangled" machines that may cause them to resist using emergency response systems. Potential users, they go on to speculate, require a loc of guidance and follow-up to ensure that the system is used properly, or used at all. One informant suggested the necessity of conducting research into ways to remind the elderly that they have an emergency response system and ways to instruct them on how to use it. The results of this research could be used to broaden use of the system, increase the level of security available to the elderly user, and perhaps reduce false alarms.

Key informants advised that those who wish a person to use an emergency response system must understand that the elderly do not want to be reminded of their frailty. This combination of difficulty with new technology and denial of impairment requires a very sensitive approach. On the other hand, a key informant who has experience with new hearing aid technology and in teaching computer skills to the elderly found that they are very keen and able learners. It appears that given a supportive environment, resistance to new technology is overcome by elderly consumers.

Another problem identified through the interviews was a lack of coordination between government departments providing shelter and support services. A provincial housing management commission (which manages the province's stock of public senior citizen's housing and provides funding for non-profit societies to build senior's housing) used to provide a hardwired emergency bell system in all its seniors units. However, the systems were monitored on an ad hoc basis, by untrained caretaking staff.

Monitoring depended either on the building janitor responding to a call or a volunteer service. In either case, the service proved to be sporadic, with far less than 24 hour a day coverage. In addition, the housing management commission and the non-profit societies managing seniors housing became concerned about their liability should they fail to respond to an emergency. Moreover, it was felt that the system allowed too great a sense of security for the low level of service provided. Emergency response systems are no longer included in this province's subsidized senior's housing. The informant felt that the initiative to provide it would have to come from the Ministry of Health.

Another example of the problem of lack of coordination was cited in another province. Government initiatives with respect to emergency response systems are hampered by the lack of a coordinated home care program to provide an administrative link between home

and hospitals. There is clearly a need for overall coordination to ensure that the elderly receive appropriate services available from varying government agencies.

One informant was very concerned about the implications of large scale use of emergency response systems. She felt that such systems would encourage social isolation and deter people's attempts to formulate an informal social support system. Along similar lines, another key informant felt that for the elderly who don't have a continuing medical problem, an informal buddy system, with daily personal contact provides a far better system and addresses a person's desire to be needed and be looked after.

Informants were also concerned about imparting a false sense of security. In many cases the emergency response will not be fast enough to save a life and the user must be made aware of the risks involved.

All informants shared the feeling that emergency response systems are appropriate for short term use for elderly patients with high medical risk who wish to shorten their hospital stay.

Overall, key informants felt that an emergency response system contributes to a senior's opportunity to remain in their home. They also felt that emergency response systems help maintain the elderly more securely at home for an extended period of time. The informant interviews confirmed that remaining independent as possible is highly desirable for the elderly. Key informants commented on the importance of routine and a familiar setting. The independence and individual control possible when living at home are strongly linked to wellbeing[17].

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17 This is confirmed in the literature. For example see M. Black "Health and Social Support of Older Adults in the Community", Canadian Journal on Aging, 4:4 1985, p. 213, and F. Gallo "The Effects of Social Support Networks on the Health of the Elderly", Social Work in Health Care, 8:2, 1982, p. 65.

Some caregivers are concerned that seniors face problems of loneliness, isolation and anxiety if they remain at home. In addition, homecare is not adequate for everyone and is not a substitute for skilled 24 hour care when necessary. Emergency response systems are a compliment to other support services for those who prefer to live at home.

Discussions with geriatric practitioners and support providers suggest the following criteria regarding the implementation of emergency response systems:

- Twenty-four hour staffing of an emergency response agency is essential. Informants also felt that emergency responders must be able to use a call back system to ensure that the alarm was not accidental.

- Systems that are uninterruptible once an emergency call is initiated, and that prevent the user from making a telephone call or receiving a telephone call for the duration of the emergency call process are considered problematic. A user should be able to easily stop an emergency alarm if they want.

- Agency staff must be well trained and able to communicate properly with '911' (emergency telephone number) and with the person initiating the emergency call. One key informant felt that the response centre should be situated where responders answered telephones as their only duty. In small hospitals (which are often the location of emergency response centres) staff have a variety of jobs, from answering possible emergency calls, responding to in-hospital emergencies and admitting patients. This multiplicity of tasks may make it difficult for hospital-based responders to deal as efficiently and sympathetically as a centre dedicated to receiving telephone calls. The key informant felt this to be particularly true when accidental calls are initiated.

- It is also considered essential that the elderly user be properly trained in the use of the system. Because the police, for example, respond to calls on a priority basis, the credibility of the system must be maintained. The user must, therefore, be careful not to initiate false alarms.

- Emergency responders are concerned that alarm system equipment be of good quality and not subject to technical problems.

THE STUDY OF
EMERGENCY RESPONSE SYSTEMS FOR THE ELDERLY

Emergency Response System Criteria

5. EMERGENCY RESPONSE SYSTEM CRITERIA

5.1 THE ROLE OF CRITERIA

Both a workshop sponsored by Canada Mortgage and Housing Corporation in Ottawa in September 1986, and consultant discussions with emergency response system industry representatives throughout 1986 revealed industry concern and interest in pinpointing product and program criteria to meet identified needs of elderly emergency response system users. The purpose of this section is to present a set of hardware (technical) and monitoring system program criteria designed to enable the industry to meet the needs of elderly users.

The criteria presented in this section will be used to evaluate the appropriateness of technological and program delivery innovations explored in the following section.

Emergency response system users fall into two general categories. The first group are those who have been recently discharged from hospital and who are at high medical risk. An emergency response system is used to alert family, community and/or health practitioners of any life threatening change to the individual, usually as a result of the illness or accident that caused hospitalization. The second, and potentially largest category of elderly users, are those who are medically vulnerable in a general sense due to their age, but who are not at high risk. Both groups are fully capable of living independently with varying degrees of home support and/or companionship.

Within these two categories, users vary in a multitude of ways. Some live alone with relatively little contact with other people, others have regular companionship. Some users will be highly mobile and require a system that recognizes the distance they may be from the telephone at the time of an emergency. Other users

will be bedridden for most of the time. Many elderly users may have hearing and/or visual impairments that will affect their ability to use emergency response systems. Emergency response systems must, therefore, be versatile enough to meet the varying needs of a wide range of users. The remainder of this section covers a discussion of technical and program criteria necessary for emergency response systems to respond to a wide variety of user needs.

5.2 HARDWARE CRITERIA

Hardware criteria are organized under the headings of system activation, monitoring, priority, verification, portability, reliability, universality and impact on privacy.

5.2.1 System Activation

System activation refers to the way in which a user alerts a monitoring centre or respondent that they require help. Section 3 described in detail the current standard, the portable transmitter which requires manual activation. To activate the system one or two buttons must be pressed. The button is on a small transmitter worn around the users' neck, wrist or carried in a pocket. User interviews, discussions with industry representatives and a literature review revealed that a large portion of elderly users do not wear or carry the portable transmitter regularly. Therefore, many users have no means to initiate an emergency call when they need to. The users must be able to actually initiate an emergency call themselves. However activation should not require a device that must be carried or worn, since it is too easily forgotten or rejected because of discomfort.

On the other hand, it is important to note that remote activation is still a necessity. Someone who has fallen or who is very ill cannot be expected to reach a device fixed in one place in the home. Therefore, the system should still be capable of activation from a distance, without requiring the user to wear a transmitter.

A means for passively activating an emergency response should also be included. The elderly are concerned as much with preserving their dignity after death as they are with response to an emergency. A passive system means that in the event of death or unconsciousness, the user will not go undetected for a long period of time. The passive system should minimize the chance of false alarms. It should be able to detect a break in normal activities, rather than have the user "sign-in" or "check-in" by pushing a particular button or making a phone call on a regular basis. However, the passive system still requires the user to indicate when they are away from home for long periods of time. This is most easily accomplished by an 'Away' device that is activated by users when they leave their home for longer than the agreed upon length of time used to monitor routine activity. Elderly users may have a difficult time remembering to use this feature of their system, causing false alarms.

Not all emergencies or ensuing alarm calls are related to medical problems. Elderly persons living independently may experience emergencies related to crime or fire. A system that distinguishes between types of emergencies may result in a more appropriate immediate response to the alarm. For example, if a fire alarm is received, the respondent or monitoring centre would send the fire department rather than the police as priority responders.

In addition, an emergency response system could be linked to an alarm system internal to the elderly person's home. For example, if they leave their stove on past a predetermined length of time, or if smoke or fire is detected, a warning is activated notifying the resident. If the resident fails to respond, the alarm system then notifies the monitoring centre.

In summary, an emergency response system should meet the following requirements for system activation:

- **user initiated activation**
- **remote activation**
- **activation device need not be worn or carried**
- **passive activation**
- **"Away" device to indicate irregular periods of absence from the home**
- **alarm that differentiates between types of emergencies**
- **alarm activated in response to internal warning system**

5.2.2 Monitoring

The most important technical aspect of emergency response system monitoring is that the emergency call must be received by the respondent. Fail-safe features to ensure dependability and operability at any time are essential.

Emergencies happen at all times and the emergency response system must be set up to respond at any time of the day or night. All systems reviewed are technically capable of 24 hour monitoring.

Those who receive the emergency call must know exactly what procedures to follow to ensure a prompt and effective response, while minimizing the chances of false alarm. Many monitoring centres have computer links with the incoming emergency call that provide instant access to a data base describing the user, priority health problems and preferred response protocol. Immediate access to this information aids the monitoring centre in executing its emergency aid.

This does not mean that 'stand alone' system should be rejected, only that the elderly user must understand the potential limitation of a system that is not connected to a professionally run monitoring centre. For the elderly person with a strongly knit social network who can engage committed respondents, the stand alone system may be ideal. Combined with either distributor or

community agency support to educate selected respondents about emergency protocol, the stand alone system can be effective for areas where monitoring centres are not available or for the person who wishes to maintain more personal links with those responsible for monitoring emergency calls.

Another issue is whether monitoring should be done locally or not. Many emergency response system companies have the technical ability to monitor the whole country (or continent) from one centre. No criteria with respect to this issue is presented, as either is feasible. On the other hand, there is the strong possibility of consumer resistance to the idea that someone in Toronto or Ottawa could adequately respond to their emergency in Sechelt, for example.

In summary, the monitoring system must be:

- **fail-safe**
- **available on 24 hour basis**
- **provide the respondent with relevant information about the user**

5.2.3 Priority

All emergency response systems reviewed in Section 3 use telephone lines as their telecommunications links. Most (but not all) systems are able to send an emergency call over the telephone line, even if the user's telephone line is engaged or accidentally off the hook.

Whatever means of telecommunication is used to link the user and monitoring centre, the emergency response system must be able to override other calls or signals originating with the user.

The criterion for this is:

- **emergency signals must override non-emergency signals on the telecommunications link**

5.2.4 Verification

Currently in Canada, two-way communication between the user and the monitoring centre or respondent is possible only if the user is able to get to the telephone. If the user cannot get to the telephone, no means for communication from a distance is available. For those who wear hearing aids or who are deaf, voice communications may not be possible and a TDD (Telephone Device for the Deaf) should be incorporated into the emergency response system.

The monitoring centre must be able to confirm that an emergency has occurred. Verification of the emergency provides the monitoring centre with an instant check on the nature and severity of the emergency. This means that the system must be interruptible and respondents can access the caller's line in order to verify the emergency.

In addition, the user requires assurance that their emergency is being responded to. These needs lead to the criteria of:

- **access to emergency caller's telecommunications line**
- **remote two-way communication between the user and emergency responder**
- **communication devices for the deaf**

5.2.5 Portability

Portability (meaning easy installed and removed) is important to those users who expect to use an emergency response system tem-

porarily, usually following hospitalization. In addition, no new expense or major purchase of equipment should be necessary if a long term user moves to a new home or wishes to live temporarily in another home in the monitoring service area.

In summary, the criterion for portability is:

- **the emergency response system must be easily and inexpensively moved to new or temporary accommodation**

5.2.6 Operating Range

The emergency response system must work within a reasonable radius of the base station in the home. Emergency communication should not be limited to a small area. The operating range should be enough to include the garden of an urban lot. The operating range does not have to be much greater because emergency crews must be able to locate the elderly person. Since the elderly are either unable or unwilling to wear technical devices related to emergency response system, it is unlikely they would remember or want to wear a homing device that would locate them if the operating range was greater.

- **The operating range, between the user and a control or base station, should be approximately 75 meters**

5.2.7 Reliability

The emergency response system must be reliable. Reliability is secured by redundancy or back-up features such as secondary power sources, for example. It must be possible to regularly test that each component of the system is fully operable. A built-in warning should alert a user and a monitoring centre of a system problem. Systems that rely only on the elderly to notice failure, are not adequate because there may be a significant time lag

between malfunction and identification. Therefore, the system should have:

- **redundancy or back-up features**
- **daily system checks for operability by monitoring centre**

5.2.8 Universality

Currently, emergency response systems in Canada use telephone lines as their telecommunications link to a monitoring centre. While telephones are widely available in Canadian homes, some emergency response systems require an additional piece of equipment to allow dial phones to function. In addition, homes with party lines may make it difficult for the monitoring centre to receive an emergency call. However, for the purpose of this report, use of the telephone system is considered to make emergency response systems universally available.

The criterion recommended is that the:

- **Emergency response system must be universally available**

5.2.9 Impact on Personal Privacy

The fear of invasion of privacy is associated with many new technological developments. Privacy and a sense of independence can be eroded if the emergency response system continually reminds the user that they are being monitored. The ability to remain at home should not be contingent on a significant loss of personal privacy.

The emergency response system should be easy to install and simple to operate since in many cases the user will be recuperating from the trauma of recent hospitalization. New and complex equipment will increase the sense of vulnerability and loss of control.

Therefore, the emergency response system:

- **should be unobtrusive in terms of physical presence and impact on personal privacy**
- **should be easy to install and operate**

5.3 EMERGENCY RESPONSE SYSTEM PROGRAM CRITERIA

The program refers to the delivery of emergency response system services to users. Section 3 showed that services are delivered by private security companies, private companies specializing in emergency response, and through voluntary or community agencies such as hospitals and senior citizens homes. In addition, stand alone systems are purchased and utilized by individuals who make their own arrangements for monitoring.

The headings under which program criteria are presented are program development, monitoring, user support, affordability, and servicing.

5.3.1 Program Development

In order to provide a high level of service the following should be considered as an essential part of the emergency response system program:

- **operating guidelines for management**
- **training manuals for users and respondents**
- **emergency protocol with local ambulance, fire and police established**
- **establish relationship of emergency response system program to other home support programs available for the elderly**
- **marketing strategy to target users and match with appropriate system**

5.3.2 Monitoring

The technical specifications recommend a 24 hour monitoring capability. From a service or program point of view it is recommended that the monitoring centre be staffed at all times by volunteers or paid workers who have been trained to deal with elderly people in all types of emergency situations. Monitoring staff must be trained to respond to the special needs of non-speaking, deaf and blind persons calling for emergency assistance. In addition, the special requirements of differing cultural groups and those whose first language is different from the common language of the monitoring agency, must be understood and respected. When an emergency call comes in, information on the caller should be readily available and up to date. Therefore, time and resources must be spent on record keeping to facilitate response to individual emergency calls.

The criteria for program monitoring are:

- **monitoring centres must be staffed at all times with qualified staff**
- **train monitors in emergency response protocol**
- **maintain and regularly up-date records on users**
- **ability to respond to emergency calls from the non-speaking, deaf and blind**
- **ability to respond in language of the user**

5.3.3 User Support

Since users and their needs are so diverse it is important that the emergency response system program recognize this. Users will require training (or education) in system use and follow-up to ensure they continue to understand how and when to use their system.

In addition, emergency response systems should be provided in conjunction with other home support services. Is the user eating properly? Do they have someone to help clean the house? Emergency response systems are not a substitute for rehabilitative or support programs, and the users' overall welfare must be considered.

Criteria for user support are:

- **users must be trained, with regular follow up, in the use of their emergency response system**
- **effective coordination with other home support and service organizations**

5.3.4 Affordability

Currently both the purchase of equipment and/or monthly monitoring charges are based on cost of service. While some emergency response systems are provided by non-profit groups, they generally have to charge enough to cover costs, which with 24 hour staffing, can be high. Systems discussed in Section 3 have a $20 to $35 a month monitoring and rental charge. Subsidies for low income seniors, greater use of volunteers to reduce costs, and greater economics of scale through larger numbers of users per monitoring centre are means to reduce costs for those whose low incomes prevent them from having access to such a service.

In addition, new technology may lead to cost reductions as we have seen with a wide variety of technological innovations in transisters, personal computers and so on.

A criterion for affordability is:

- **emergency response systems must be affordable for all elderly, regardless of income**

5.3.5 Servicing

If a system problem becomes evident, skilled repair people and appropriate equipment and tools must be immediately available. The servicing criterion is:

- **same day repair and/or replacement must be provided.**

THE STUDY OF
EMERGENCY RESPONSE SYSTEMS FOR THE ELDERLY

Innovations in Technology

6. INNOVATIONS IN EMERGENCY RESPONSE SYSTEM TECHNOLOGY

The criteria developed in the previous section are used to evaluate different types of emergency response system technology available outside Canada, and to discuss the applicability of other technological advances to emergency response systems. The research method included:

- o a review of American product literature
- o a literature search[18]
- o telephone interviews with key 'technology and aging' researchers in Canada and the United States[19]
- o technology review by consultant's engineers

6.1 ADVANCES IN EMERGENCY RESPONSE SYSTEM TECHNOLOGY

There are three major advances in emergency response system technology available outside Canada. They represent major improvements in system activation, verification of the emergency and universality of service. However, a summary matrix (Table 1) shows that none of these products meets all the technical criteria established in Section 5.

6.1.1 System Activation

Systems currently exist in the U.S.A. that include both a passive inactivity alarm that does not require the user to remember to prevent a false alarm, and a remote control transmitter to manually activate the emergency response system. Auto sensors installed in the user's home detect interruption in their normal activities. The telephone, refrigerator, bed lamp, television or any other appliances can be used to monitor activity. Once a break in normal activities is detected, the system automatically dials a monitoring centre, and a phone call is made to ensure the

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[18] Literature references for technological innovation are found in Appendix 6.

[19] A list of persons contacted is included in Appendix 7.

TABLE 1
EVALUATION OF ADVANCES IN EMERGENCY RESPONSE TECHNOLOGY

	EMERGENCY RESPONSE SYSTEM				
TECHNICAL CRITERIA	Passive/ Active System	Two-way Voice Communica-tion	Long-Range Radio Security	P.A.S.S.	S.C.A.N.
System Activation					
o user initiated	*	*	*	*	*
o remote activation	*	*	*	*	*
o activator not worn/carried					
o passive activation	*	*			
o 'Away' device	*				
o differentiate between types of emergencies		*			
o internal warning system					
Monitoring					
o 24 hour	*	*	*	*	*
o fail-safe	*	*			
o information about users	*	*			
Priority					
o emergency call override	*	*	*	*	*
Verification					
o two-way communication		*		*	
o access to user's telephone lines		*			
o communication devices for the deaf					
Portability					
o easily moved		*	*	*	*
Operating Range					
o 75 meters plus	*	*	*	*	*
Reliability					
o redundancy	*	*			
o daily system checks	*	*			
Universality					
o universally available	*	*	*	*	*
Impact on Privacy					
o unobtrusive					
o easy to install/operate		*	*	*	*

*Product meets criterion

person is alright. The only restriction is that the user must notify their monitoring centre if they intend to be away from the home for an unusual length of time.

This system evolved from detection technology originally developed for military application. The sensors operate on the principle of passive infrared technology. The sensors do not emit energy (as do ultrasonic, microwave, and light sensors).

In addition to monitoring daily activities and emergency health response, the system has buttons that can be activated specifically in case of fire and/or home break-ins. The system has built-in battery back-up power supply and the home equipment self-checks with the monitoring centre computer once every twenty-four hours.

The passive inactivity features of an emergency response system, combined with active alarm activation are important because they:

- o Provide comprehensive coverage throughout the house.
- o Provide assurance that the user will not be left in need for more than a predetermined number of hours.
- o Do not require the user to prevent false alarms.

6.1.2 Verification

Another product widely available in the U.S.A. and Europe is a two-way voice communication system. Like other emergency response systems, the two-way system consists of an activator - a push button on a bracelet or pendant - and a base station. If activated, the encoded signal is sent through the base station over telephone lines to a monitoring centre. At the same time the emergency alert signal also activates an intercom system. The monitoring centre operator can then speak, through the base station, to the person who has signalled for help. The user can answer as far as 18 metres from the base station. Sensitive

microphones even pick up low levels of noise, such as moans, at this distance.

The two-way voice communication system improves on the existing systems used in Canada in five important ways. These are:

- o Decreasing the time between call for help, knowledge of need and response.
- o Eliminating the need to always contact a neighbour/friend/relative prior to dispatching emergency assistance.
- o Enabling the responder to comfort the user while waiting for help.
- o Reducing response to false alarms.
- o Being more reliable - a neighbour/friend/relative may not always react appropriately; the monitoring centre operator is trained for emergency response.

6.1.3 Universality

Three products are available which would allow universal application - there are no limitations imposed by telecommunication links such as telephone lines.

Long-range radio transmission does not depend on telephone lines. Frequency-modulated (FM) radio signals are sent by a transmitter which is programmed to emit different signals depending on the nature of the emergency - health, fire or crime related.

This is an improvement on existing systems because:

- o Users do not need to be near a telephone.

However, the transmitter device is bulky, and not easily worn. Radio waves are also subject to interference from obstructing steel structures which may effect the transmission of the emergency signal.

Another example of a system that by-passes the telephone line is a personal alarm security system.[20] Used primarily as a crime prevention technique, it was tested by older persons in New York. Volunteer seniors carried a small radio which provided immediate contact with police. Each radio has a unique frequency that identified the caller. The caller can communicate with police; if the senior is unable to speak, a locator can inform the police of the senior's geographical situation.

The advantage of the personal security system is the same as the long-range radio system. In addition, it allows seniors two-way communication with emergency departments. However, the devices are not easily worn and not easily monitored due to the need to locate people in a large geographic area. The system is designed for a street and outdoor environment rather than a home environment. A locator feature is not necessary for home medical alert systems; long-range communication is not necessary when a telephone jack is accessible.

Another personal security system is based on space technology (N.A.S.A.). It operates in a similar manner to the personal security system, except ultrasonic waves instead of radio frequencies are emitted. An ultrasonic pen-size transmitter is worn by the user. In an emergency situation, the user presses the pen clasp. The pen then emits a strong pulse of silent ultrasonic energy. An audio alarm is set off at a monitoring centre; a light indicates the user's location.

This system was developed primarily with crime protection in mind. The application is most suitable in a street setting and not a home environment. However, further experimentation with ultrasonic technology could eliminate the need for a telephone link to

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20 J. Faris, "Technology Promises Increased Convenience and Challenges to the Nation's Elderly," Aging, 1983, and N.A.S.A. Staff, Washington, D.C. interviewed November, 1986 by MacLaren Plansearch.

a monitoring centre. However, the utilization of a telephone line is more practical then the utilization of narrow beam ultrasonic waves which are subject to interference - for example interference when two persons signal in the same area. In addition, the monitoring centre is not told who is sending off the ultrasonic signal or given any clues as to the nature of the users problem as no encoded data is transferred. It should be noted, however, that outside of the home environment an ultrasonic system may be more reliable than a FM radio frequency system.

6.2 TECHNOLOGICAL ADVANCES APPLICABLE TO EMERGENCY RESPONSE

Several technologies are currently available or in development stages that appear to have some application to emergency response systems.

The terms 'Smart House', 'Tomorrow House', 'Smart Design' and 'Intelligent Buildings' describe technologically advanced construction. Computerized telecommunications, computer controlled environments, single system home wiring, and built-in life support systems are all features of today's building innovations.

These innovations and others related to communications technologies are discussed within the context of their applicability to emergency response systems.

6.2.1 System Activation

Biotelemetry was originally designed to monitor and measure animals for scientific and conservation purposes. N.A.S.A. adapted this measurement technology to monitor vital functions of astronauts. Presently, biotelemetry implants are being used to monitor insulin levels and electrocardiogram (ECG) signals and activate emergency help when it is required.[21]

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21 Raymond Whitten, N.A.S.A., interviewed November 1986, by MacLaren Plansearch.

The biotelemetric unit is a programmable and implanted medical alert system. Implant units are pre-programmed to pick up, for example, changing insulin levels or ECG wave lengths which transmit an emergency signal via a base station over the telephone line to a hospital, if insulin levels or ECG signals change dangerously. This type of innovation would eliminate the need to remember to wear a portable transmitter.

In addition, a user is given a hand held unit, about the size of a cigarette package, to manually activate an emergency response or to adjust the implant. For example, a diabetic would adjust his or her insulin level prior to eating a large dessert. However, this costly and highly intrusive programmable and implantable medical system is only appropriate when considering users with extreme medical risks.

There are many innovations in computer technology using voice activated commands to initiate programmed responses.

Computer speech recognition and responding task performance is still in the developmental stage. However, computer recognition of vocabularies of up to 10,000 words is not far off[22]. Computers can currently interpret and act on small vocabularies to accomplish limited tasks. Research and development efforts are being focused on a wide variety of equipment and machinery that responds to human speech to perform a variety of household tasks. However, since activation of an emergency response system only requires a very small vocabulary, the potential to link users and the monitoring centre this way is currently feasible.

For example, with a home computer and various peripherals, a telephone can be dialed by saying a person's name. It is possible

22 See Computer Design, (July 1986) and New Scientist, (May 1986).

therefore, to vocally command the computer to activate a control unit which will in turn dial a monitoring centre allowing a user to communicate over the telephone with responder. The word 'help', when spoken, could be pre-programmed to contact the monitoring centre for emergency assistance. This type of innovation eliminates the need for a mike, pendant or "panic button" to be worn by the user in the home. To extend the range of voice control a wireless microphone could be worn when in the garden or out of range of the communicator device.

Researchers at the Technical University of Darnstadt have designed microphones that are smaller than a head of a pin and incorporate enough space to integrate electronic circuitry and an amplifier for signal processing[23]. Miniature microphones and amplifiers can be used to both enhance two-way communication between the elderly person and the monitoring centre and to facilitate voice control of an automatic telephone dialler.

Voice activated telephones are also possible without the use of a home or personal computer. Voice activated cellular telephones are currently available in England and the U.S.A. The telephone responds, once programmed, to single word commands. Numbers pre-programmed by the user, can be dialed by speaking the person's or business' name. The voice command can also be linked to a home telephone. For example, it can be programmed to dial the fire station whenever it hears the word "fire".

The combination of powerful miniature microphones and voice command programmable telephones to initiate dialing to an emergency response centre could eliminate the need for any wearable or portable radio-type alert button. By differentiating between emergency types by simply calling "police", "fire" or "help", response appropriate to the situation can be more easily given.

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23 Electronics, April 28, 1986.

Other innovations in data transfer over telephone wires suggest that it might also be possible to ensure that the monitoring system not only receives a voice activated call but will receive pre-programmed information about the persons health condition and preferred response protocol.

An innovation with respect to passive inactivity emergency alert is the use of electrical micro switches. Electrical switches installed in a person's refrigerator, on their television switch and/or on a variety of other home appliances can signal to a base unit that the user is active. If a break in normal activities is detected, the base unit sends a message to a monitoring centre. These switches can also be used as an internal alarm system to indicate when, for example, a stove has been left on for an unusual length of time. To retrofit a home with these devices is a relatively inexpensive, simple task compared to installation of laser, infrared or heat sensors.

6.2.2 Universality

The majority of emergency response systems discussed in this study utilize telephone lines to transmit an emergency message. Radio waves and ultrasonic waves have also been discussed as a telecommunication transfer. There is another area of technological innovation that may increase the availability of emergency response system.

Coaxial T.V. cable has the ability to transmit data, voice and video. A system stimulated by inactivity sensors and/or an activation device can transmit emergency signals over cable to a monitoring centre. Ultimately such systems could incorporate two-way video interaction, allowing a person to stand in front a camera and call for help.

However, for two-way (or one-way) transmission over cable, the introduction of fibre optic cable by cablevision systems (now in early development stages) would be required to provide the capacity necessary for multi channel two-way band communications. This technology is not widely available and is likely to remain highly centralized in urban areas.

These kinds of technologies will required specialized equipment that is not available in all homes. T.V. cable service is not nearly as wide spread as telephone use. In addition, the use of visual communications begs the question of privacy and intrusion in the home. Reliance on a fixture such as a television also reduces mobility for the user.

6.2.3 Verification

Research shows that in the near future Canadian telephones will be able to transmit not only voice and data, but video signals as well, due to the increasing use of fibre optics in the telecommunications network.[24]

Picture phones currently available utilize telephone lines to transmit video and voice communication. However, the quality of picture is poor due to the limited band width of voice grade telephone lines. Consequently two-way or one-way video emergency response systems are more likely a system for the future when wide band telecommunication systems are put in place.

A two-way video teleconferencing system is available that utilizes light waves. They have three standard video conferencing configurations. These include point-to-point video conferencing, broadcast video conferencing and point-to-multi-point video

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[24] V. Biancomano, "Fibre Optics", Electronic Design, 1986.

conferencing. Point-to-point is the simplest way to connect one location to another, with full two-way video and audio capability. Broadcast video conferencing connects three or more locations with calls and receives video and audio signals initiated from any one location. Point-to-point video conferencing provides for video and audio interaction of multiple locations. System features also include voice-activated control, through microphones, of the communications.

The use of existing telephone lines to visually link user and monitoring centre provides a forceful way in which to verify an emergency. However, the impact of visual monitoring on personal privacy may be so negative that market resistance might prevent wide spread use of this development.

6.2.4 Operating Range

Technology that increases the distance between the user and a base or control station that receives and transmits an emergency alert increases the mobility of the user. Technology such as long-range radio communication, and ultrasonic waves (discussed under the heading "universality") enable the user to make an emergency call and be easily found by emergency responders.

A third telecommunication innovation that increases the operating range, and hence the mobility of users, is cellular technology.

A cellular telephone network involves a geographic grid of hexagonally shaped cells, each with an antenna which is connected to a switching station which in turn is connected to a regular telephone line. Cellular technology allows a person to access the telephone system from any recognized cellular location - most likely an urban location. Using speed-dialing (or voice activation), a cellular telephone can be pre-programmed to contact an emergency response centre. A cellular phone is not yet a wearable device. The application of cellular technology to emergency

response system would most likely involve urban seniors who need emergency communication from their cars, wheelchairs and areas outside of the range of a home emergency alert. Cellular telephones do not locate the user - the emergency responders would have to confirm the elderly person's location over the telephone.

6.2.5 "The Smart House"

The last innovation to be discussed is the 'Smart House'[25] or 'House of the Future'. This innovation, although more comprehensive, is a variation of the computer controlled environment. The ,Smart House' involves retrofitting a home or building a new home with a single cable capable of handling all electrical needs in a house. All home appliances are centrally controlled as are telephone, security systems, T.V., and heat system by a control box and/or home computer.

A central computer can exercise automatic (pre-programmed) control, or functions can be manually controlled, either directly from a key board, or remotely by any one of a number of controls such as a voice, sensor or manual activator. Having a home controlled in such a way could decrease heating costs and increase life of electrical products due to controlled current use. This sophisticated computer control system not only controls the home environment but protects against forgetfulness in leaving appliances on and also reminds the occupant of appointments or tasks for the day. These systems, currently marketed at approximately $4,000 to retrofit a home, completely control electrical and mechanical household functions.

To integrate an emergency response system into a 'Smart House' system involves pre-programming a computer to respond to an emergency alarm.. passively, manually or vocally activated.

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25 'Smart House' is a registered trademark of the American National Homebuilders Association.

Simpler versions of the electronically controlled house are also available. A unit that plugs into a T.V. set allows control of appliances, energy and displays a menu of chores, etc. The device communicates over standard electrical wires to small modules attached to appliances. The device can also respond to telephone calls of residents wishing to command the system to turn the heat down or to do other programmed functions. It could also possibly operate an emergency response system. All functions can be remotely controlled.

Even if the costs of retrofitting a home to a 'Smart House' or a similar system were reduced, the level of the technology may be too complex for general use by the elderly. On the other hand, as use of computer related technology becomes more common the system could be designed to assist independent elderly with all their daily tasks and prevent dangerous use of appliances. This assistance, combined with an emergency response system that allows voice command to activate emergency response, could significantly contribute to elderly independence.

The 'Smart House' is important because it includes emergency response capability as part of a total communications system. With this system, not only does the user have the opportunity to send an emergency alarm out, but messages can be sent from outside the house by someone monitoring the system. The monitor can electronically activate a response which may greatly help those elderly who easily forget such things as turning the stove off.

THE STUDY OF
EMERGENCY RESPONSE SYSTEMS FOR THE ELDERLY

Innovations in Delivery

7. INNOVATIONS IN EMERGENCY RESPONSE SYSTEM DELIVERY

The key issues with respect to the delivery of emergency response system programs are:

- **who pays for the system**
- **who organizes the system**
- **who manages the system**

Currently a variety of private, public and community or non-profit agencies are involved in the three aspects of system delivery: capital and/or operating costs; program organization; and system monitoring.

Various combinations of service structure and delivery mechanisms are possible at the private, public and community service or non-profit levels. The following table illustrates possible emergency response system service and delivery through private, public or community service sectors. It is important to note that a complete system can be provided with participation from a combination of sectors, or by each sector individually.

For example, a service club could pay for purchase of equipment. A provincial ministry of human resources or welfare could choose users, establish the emergency protocol, train users and then have a private security firm actually monitor the calls. While this would require a large effort to organize the many agencies to deliver this service, any combination is possible.

Two improvements to existing Canadian emergency response system delivery and service have been identified. The first is in the private sector, the second in the public.

TABLE 2

POSSIBLE SERVICE AND DELIVERY

DELIVERY MECHANISMS

	OPTIONS FOR DELIVERY OF EMERGENCY RESPONSE SYSTEMS		
FUNCTION	PRIVATE SECTOR	PUBLIC SECTOR	COMMUNITY AGENCY SECTOR
Capital and/or Operating Costs	o User pay o Provided by Housing Developer	o Medical Services Plans o Hospital budgets o Long Term Care Program budgets	o Service clubs and non-profit organizations
Organize Emergency Response System	o Security firms o Distributors o Individuals	o Ministry function (either senior's bureau, housing commission, etc.) o Hospital/long term care facility	o Service clubs and non-profit organizations
Monitor System	o Resident Association o Friends/relatives (stand alone system) o Security firms	o Community Emergency (911) o Hospitals o Public long-term care facilities	o Service clubs and non-profit organizations

7.1 PRIVATE SERVICE STRUCTURE AND DELIVERY MECHANISMS

Many market or private sector housing projects oriented to senior citizens incorporate emergency response systems at the construction stage. The renter or owner of a unit can choose to have his or her unit monitored and the cost of the system is built into the selling price and monthly fees or rent. Monitoring for fire, security and medical reasons is done either by in-house staff, or by an outside monitoring company or organization that monitors many buildings at once.

As consumer demand increases, emergency response systems could become a standard feature in new purpose built or targetted seniors housing including all public, private and non-profit projects. As more seniors and resident-funded seniors housing is developed, there will be more opportunities to include an emergency response system as a standard feature, such as kitchen appliances are considered.

The system is most likely to be available in newer, more luxurious housing complexes. In addition, the quality of the emergency response will depend on the monitoring method used in each residential complex. However, the potential for increasing system availability and reducing individual costs due to economy of scale is large using new housing delivery mechanisms.

7.2 PUBLIC SERVICE STRUCTURE AND DELIVERY MECHANISMS

Public agencies which provide and manage subsidized housing for the elderly are increasingly faced with high concentrations of frail elderly in their housing projects. These agencies can anticipate an increase in the incidence of accidents, fires and floods related to their elderly tenants.

By providing an emergency response system as part of the subsidized housing package for the elderly, public agencies can reduce emergency risk for their tenants and reduce potential large scale damage caused by fire and flooding.

In Denmark, a program to enable the elderly to remain in their homes and within their communities includes a mobile care system[26]. A twenty-four hour emergency response office at a municipal social service centre, nursing home or, a fire station remains in contact with a municipal mobile care centre. The mobile care centre consists of a nurse, nursing assistant and supplies. The mobile care centre makes regular visits and emergency visits in response to emergency response system alarms.

The Danish government integrates independent housing and public care for the elderly. A similar role for Canadian public agencies could be to implement emergency response systems as part of an integrated home care program. An emergency response system delivered by a provincial or municipal government home care program, combined with a comprehensive home care service, has the potential to reduce institutionalization while improving the quality of elderly home care. For those who have privately organized systems, the municipal system has the potential to act as a back-up resource.

Public agencies can also pay for equipment and monitoring. The cost of purchasing the hardware, combined with monthly monitoring charges is prohibitive for many elderly on low fixed incomes. A public delivery program for emergency response systems can include full or partial subsidy.

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26 K. Moller, "Denmark Explores Technology's Care Potential for Home," Aging International, Winter 1985.

A review of the ten provincial medical plans shows that eight provinces provide medical coverage without charge to their senior citizens. New Brunswick requires a reduced premium (or no charge for those on Guaranteed Income Supplement) for its seniors. Only British Columbia charges full premiums to its senior citizens[27]. Most provinces already offer financial assistance for pharmaceuticals, and some subsidize prosthetic and orthotic devices or hearing aids and pacemakers. This brief review provides an indicator of the precedence for provincial financial assistance for the elderly through medical insurance plans.

Provincial medical insurance plans offer a good vehicle to subsidize emergency response systems for those seeking early release from hospitalization, and temporary use of an emergency response system while recuperating. This type of subsidy may require a doctor to "prescribe" use of an emergency response system.

For those seniors who do not require hospitalization and who are attempting to extend their stay in their existing homes, funds for emergency response systems could be allocated through municipal and provincial long term and home care programs or through housing programs. Emergency response systems overlap in impact on both housing and health public policy. Innovative programs drawing funds from both areas should be considered as a means of extending the availability of emergency response systems for the elderly. Other possibilities include allowing an income tax credit or deduction to help cover the cost of such systems. Once a commitment to increasing access to emergency response systems has been made a variety of programs can be used to reduce the cost to the elderly.

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27 Assistance with medical premiums is available to those with annual household income of less than $3,160 based on the previous year's income tax returns.

THE STUDY OF
EMERGENCY RESPONSE SYSTEMS FOR THE ELDERLY

Estimating the Demand

8. ESTIMATING THE DEMAND FOR EMERGENCY RESPONSE SYSTEMS

The demand for emergency response systems will depend on several factors:

- o the growing elderly population
- o the cost of emergency response systems
- o the provision of other home care services that promote independent living
- o a relative lack of institutional accommodation
- o marketing strategy used by companies promoting ERS
- o criteria used to target users

The growth of the Canadian elderly population is predicted to be rapid. According to Statistics Canada projections, the Canadian population aged 65 and over will increase 52% between 1986 and 2006, for a total of approximately 4.1 million elderly[28]. By 2031 this figure could increase to over 7.5 million persons aged 65 and over. Emergency response systems may not be necessary or appropriate for every elderly person. But compared to the estimated 6000 - 7000 seniors currently using emergency response systems, the potential magnitude of expansion possible is illustrated.

As the cost of emergency response systems decreases, the demand is likely to increase. The current cost of emergency response systems (often $20.00 to $35.00 a month rental and monitoring charges) is high enough to seriously deter many elderly Canadians who are on a small fixed income from considering its use.

In many cases, emergency response systems could form a part of a 'package' of other support services to enable the elderly to remain at home. There is a growing trend towards emphasizing home

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28 Statistics Canada, The Seniors Boom. 1986.

care as an alternative to institutionalization. For example, in British Columbia, 20 percent of long term care placements are being considered for replacement in the community. It is estimated that between 4.3 percent and 15 percent of elderly require home care. The propensity for seniors to use home support services varies with availability, level of impairment, marital status, and living arrangement[29]. It is assumed that these factors will also affect use of emergency response systems.

As places in institutions become harder to come by, the need for services that to some extent duplicate care will increasingly become in demand.

With respect to marketing, it is the ability of emergency response system companies to reach the families of seniors and the medical profession, as well as the elderly, that will affect demand. As user interviews suggested, seniors are rarely found to request emergency response systems on their own initiative. In addition, when senior citizen's groups across Canada were contacted by the consultant, few had heard of emergency response systems or could identify even one of the many available systems. For whatever reasons, companies marketing emergency response systems have, to date, failed to reach seniors themselves.

On the other hand, demand may be limited by criteria for use developed by institutions and/or agencies that provide emergency response systems. Criteria that are used can be:

- o patients assessed for extended care who are in the hospital waiting nursing home placement.

- o seniors who live alone and have no family support but do have other sufficient community support.

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29 A.M. Clarfield "After Medicare - Problems in Home Health Care in Quebec, Canada", Pride Institute Journal, 3:3, 1984, p. 12.

- o seniors who live in the community and who have family support, where their family support also works and is unavailable during the day.

Some emergency response system programs only target seniors who have strong social support systems and who are quite healthy and mobile, believing that emergency response systems are best suited to these seniors[30].

In conclusion, the demand for emergency response systems is not based on a simple calculation but is derived from an evaluation of complex variables outlined above.

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30 S. Sherwood and J. Morris, A Study of the Effects of an Emergency Alarm and Response System for the Aged, Boston, MA: Rehabilitation Centre for the Aged, 1981.

THE STUDY OF
EMERGENCY RESPONSE SYSTEMS FOR THE ELDERLY

Issues Related to Cost-Benefit Analysis

9. ISSUES RELATED TO COST-BENEFIT ANALYSIS[31]

The terms of reference for this study require a cost-benefit analysis comparing the use of emergency response systems with institutionalization. As with most cost-benefit analyses, the task is more complicated than it first appears.

First, the costs and benefits are accrued to a variety of groups and each must be considered. They include the actual elderly user, the user's family, the long term care system, the home care system and the hospital system.

Second, emergency response systems are used for a wide variety of purposes. They are used to provide a sense of security for both health-related and personal safety-related fears. In this case, the elderly person often uses an emergency response system for the duration of their life. On the other hand, another common use is for potential acute medical emergencies, following a period of hospitalization. In this circumstance the use of an emergency response system is often a short term proposal.

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31 Issues related to costs and benefits of ERS are drawn from the following literature:

J. Birren et al. "Evaluation of a Personal Emergency Response System", Aging and Technological Advances, New York: Plenum Press, 1983.

A. Dibner, Effects of Personal Emergency Response Service on Hospital Use. Waterton, MA: Lifeline Systems, 1985.

W.J. Koch, Royal Alexandra Hospital's Lifeline Program: Annual Report. Edmonton: Royal Alexandra Hospital, 1985-86.

C.W. Schwenger and J.J. Gross, "Institutional Care and Institutionalization of the Elderly in Canada" in V. Marshall ed., Aging in Canada, first edition, Don Mills: Fitzhenry and Whiteside, 1980.

S. Sherwood and J. Morris, A Study of Effects of an Emergency Response Alarm and Response System for the Aged, Boston, MA: Rehabilitation Centre for the Aged, 1981.

Sterling and Associates, Rainy Crest Home for the Aged - Home Care Support Services, Ontario: Ministry of Community and Social Services, 1986.

A third issue is that for those who may require institutionalization, emergency response systems, on their own, do not provide a single alternative for formal or institutional care. The system is only one part of a range or spectrum of home support services that can assist the elderly in maintaining their independence. Depending on a person's level of need for care and access to informal and formal social support systems, remaining in one's home may be an appropriate and a cost effective alternative.

With respect to costs, savings in institutional care may cost tax payers or the senior (and the family) in home care. To provide effective home care, support systems must be put in place that complement a service such as emergency response and services provided through informal support systems. The nature and extent of the complete support "package" (including an emergency response system) will depend on the individual circumstances of each elderly person. And of course, over time, the type and amount of services will change as needs change. It is therefore, extremely difficult to quantify the costs and benefits associated with the possible widespread adoption of emergency response system.

In addition, qualitative costs and benefits are very difficult to quantify. Canadian geriatric practitioners realize that for the elderly, wellness and a sense of control over one's life comes from living independently in a familiar setting. Staying at home provides, in many cases, a higher quality of life than possible through institutionalization. It is these qualitative issues that confound the cost-benefit analysis.

The following points highlight some of the issues related to the costs and benefits of systems to elderly users, families of the elderly, long term care, home care, and hospital systems and to society in general. Costs and benefits to each group are considered separately. Both quantifiable and qualitative factors are included under each heading.

9.1 COSTS AND BENEFITS TO ELDERLY USERS

Costs

- Installation fee and rental or purchase of emergency response system.
- Homemaker and/or other support services.
- May increase isolation by reducing need for daily personal contact.
- May promote a false sense of security.
- For some users, may increase sense of vulnerability.
- May be used as a substitute for more appropriate institutional care.

Benefits

- Reduces time in hospital and/or long term care facilities.
- Extends ability to remain in own home.
- Increased security.
- Immediate response to emergency.
- Peace of mind - reduction in anxiety.
- Reduces fear of being alone.
- Prolongs independence and use of informal support system.
- Increases sense of good health.
- Increased mobility in home and garden.

9.2 COSTS AND BENEFITS TO FAMILY

Costs

- Subsidizing purchase or rental and monitoring of emergency response system.
- Requires family to take on more responsibilities than if senior was institutionalized.

Benefits

- Enables adult children of the elderly to balance care and employment.
- Increased independence and decreased sense of burden.
- Decreases feelings of anger towards aged relative.

9.3 COSTS AND BENEFITS TO LONG TERM CARE SYSTEM

Costs	Benefits
	o Delay of entry into long term care.
	o Reduces need for some levels of care.
	o USA estimates show that for every $1 spent on emergency response systems, $7.19 on long term care was saved.
	o Canadian research shows that between $1,264.2 million and $2,065.7 million could be saved annually by substituting chronic home care for institutional care. Emergency response systems could be one component of chronic home care system.

9.4 COSTS AND BENEFITS TO HOME CARE SYSTEM

Costs	Benefits
o Increased use of emergency response system may lead to further demand for home care services.	o Home care, combined with emergency response and informal support costs less than long term care.

9.5 COSTS AND BENEFITS TO HOSPITAL SYSTEM

Costs

- Capital and operating costs of monitoring hospital-based emergency response system.

Benefits

- Reduces hospital stay: Users in Edmonton experienced 28.2% decrease in hospital admissions, 49% decrease in in-patient days, 9.5% decrease in emergency room use and 28.9% decrease in length of hospital stay. In a USA study, hospital admission of users decreased by 23.2% and emergency visits decreased by 6.5%.

9.6 COSTS AND BENEFITS TO SOCIETY

Costs

- Over consumption of housing if elderly remain in single family houses.
- Relies heavily on volunteer help to reduce costs. As more women work, have to be careful about developing a home support system based on a declining informal support system.
- Capital and operating costs of other services necessary to complement emergency response systems.

Benefits

- More efficient use of long term and hospital care systems.
- Assists in changing attitudes to institution-alization.
- Reduces segregation by age groups.

Conclusions

10. CONCLUSIONS

The growing elderly population in Canada has encouraged public policy makers to consider ways to reduce the demand for costly institutions and increase the individual's opportunities to remain independent. Emergency response systems (ERS) are technological support services that currently help to bridge the gap between accommodation and supervised care for elderly Canadians.

From the outset, this study discovered that telephone emergency response systems are far superior to other informal types of emergency response systems such as postal alert.

The availability of:

i) 24-hour monitoring;
ii) fail-safe features;
iii) flexibility of application; and
iv) availability of both active and passive alarm initiation, distinguish most telephone systems.

One of the main disadvantages of telephone emergency response systems compared to other types of emergency response systems is their cost. Equipment purchases can include monitoring equipment that costs in excess of $5,000 and a "home unit" priced in the $400 - $1,500 range. In addition, monthly monitoring charges for staffing, telephone service and "office overhead" can be added to these capital costs. In contrast, most of the non-electronic systems had no equipment costs and were run on a volunteer basis.

Multiple unit dwellings composed mainly of seniors offer an opportunity to provide lower cost high technology emergency response systems than possible for seniors living at lower densities. In Ontario alone, 60,000 multiple unit senior's buildings are managed by public agencies. With such concentrations of potential

emergency response system users in apartment buildings a hardwire system may provide an efficient and cost effective solution.

While the telecommunications link would be "hard-wired" throughout the seniors' apartment building, residents could be provided with remote control transmitters to activate an emergency alarm from anywhere in their apartment. The emergency alarm could be received by a computer that monitored several buildings at a time. The computer would then forward the emergency alarm over telephone lines to a monitoring centre, or to individual respondents as in the case of stand alone systems.

The advantages of a mixed hardwire/telephone networked system in multiple unit buildings could be a reduction in the capital cost of the equipment for both new and existing buildings. In addition, operating costs for monitoring may also be lower due to an economy of scale. Since the emergency response system is part of the building fixture it may also be possible that the system is less prone to rejection due to age stereotyping or invasion of privacy objections.

Emergency response systems also require users to master a level of technology with which they may not be familiar. However, interviews with a variety of practitioners, support providers and actual users of emergency response systems suggests a growing widespread interest, tolerance and appreciation of emergency response systems. This interest is strongly linked to the current theory that elderly people should be encouraged to live independently for as long as possible.

At the very least, it is anticipated that the demand for emergency response systems will increase as the elderly population grows. The elderly population is expected to grow approximately 50% in the next twenty years, so there is every reason to believe that at a minimum, the proportion of potential emergency response system users will continue at the same rate.

However, there are several factors which may actually increase the proportion of elderly using emergency response systems. These factors include:

- o a marked decrease in the cost of emergency response system;
- o the provision of other home care services that promote independent living;
- o a real shortage of institutional accommodation; and
- o marketing strategies used by companies promoting emergency response systems.

A change in any of these factors could greatly influence the demand for emergency response systems.

To date, two groups of elderly are perceived to be the most appropriate users of emergency response systems. The first "group" are those who experience short term medical vulnerability The emergency response system is primarily used to reduce the length of a hospital stay and to provide short term assistance at home during the recuperation period.

The second "group" of elderly perceived to be the most appropriate users are those who are "at risk" in a general sense, but who are fully capable of living independently and who are seeking ways to extend their ability to maintain their independence.

Any cost benefit analysis comparing in-home emergency response systems to institutionalization is complicated by a multiplicity of factors, related to both quantitative and qualitative issues. It has not been possible, within the scope of this study, to demonstrate categorical savings or economies of scale vis-a-vis emergency response systems or nursing care institutionalization. However, there is much evidence in the literature reviewed, and in key informant interviews, that reductions in costs for institutionalization do occur. Other benefits identified include the

reduction of anxiety by both the elderly and their families and of course, by immediate response to emergency situations.

The review of existing emergency response systems and recent improvements in Canada, the U.S.A. and Europe indicate a strong and responsive industry. A constant theme in discussion with emergency response system representatives is their willingness to respond to identified user needs.

10.1 KEY AREAS FOR TECHNOLOGICAL IMPROVEMENTS

This study has indicated that improvements are needed in several key areas. First, the need to wear or carry an alarm activator should be eliminated. A review of applicable technology suggests that voice activated systems should be closely considered. One advantage of voice activation is the ease in differentiating between the need for health, fire or crime related emergencies. Voice activated alarm systems need to be tested for user acceptance and user ability to remember how to activate the system under varying emergency conditions. The cost implications of such computer-related technology also need to be considered.

Another option that could be tested is the use of inexpensive adhesive switch strips with built in transmitters. These could be placed anywhere, including baseboards, over the bath and on furniture, giving users the ability to activate an alarm from a large number of areas in their home.

Remote two way communication is not an innovation - it is already widely available in the U.S.A. However, it needs to be tested to evaluate whether users find this system useful or an invasion of privacy.

The second area of improvement required is to make delivery of emergency response systems more wide spread, to lower cost per

unit and to test emergency response system's role in conjunction with other services related to independent home life. This suggests the need for a program that integrates homecare services, community emergency services with the provision emergency response systems. Most communities in Canada, with increasingly well developed community support, long-term or homecare are well placed to provide an infrastructure.

A third area of improvement in emergency response system technoiogy is to link the system to a comprehensive internal warning system. For example, if an elderly person forgets to turn the stove off, they would be notified through this internal alarm system. An internal alarm system could also serve for smoke, fire and flood detection, thereby reducing the potential of large scale emergencies, particularly in multiple unit dwellings.

Another area for improvement is to test those technologies which allow emergency response when a person is away from their home, therefore increasing individual mobility. These systems require homing devices to locate the user, and may suffer the same fate as indoor pendent transmitters. How the need for homing devices (which are required for an outdoor environment) affects usage and emergency response, should be evaluated.

10.2 KEY TECHNOLOGICAL FEATURES

Existing emergency response systems have key features which should be continued in any future system configuration. First, use of telephone lines has proved reliable and widely accessible for users in all parts of the country. No telecommunications links examined (cable T.V., ultrasonic waves, radio frequencies) appear to provide a superior alternative or are so universally distributed and accepted.

Secondly, existing computer monitoring capability used by staffed monitoring centres provides the means to immediately instigate an emergency protocol. Information about the user is readily available, through the computer data base, and monitoring centre staff are able to act with the most appropriate response indicated by this source of information.

Thirdly, systems that combine a user initiated alarm with a passive inactivity alarm allow the possibility of signalling an emergency at user discretion and by default if the user is unconscious.

Fourth, stand-alone systems should be encouraged for those whose medical risk is low but for whom peace of mind is important. Stand-alone systems do not require expensive monitoring and provide an appropriate level of response for those who are well integrated in a social support network.

In order to test new innovations and system configurations it is recommended that a demonstration project be undertaken to develop the technology and implement and monitor an emergency response system that meets all the criteria established in Section 5 and incorporates the following features new to Canadian emergency response systems:

- o activation systems that are not worn by the user
- o remote two way communication
- o multiple warning system for health related emergencies, smoke/fire protection, crime and so on.
- o accessory transmitter/homing device for away from home use
- o linked to local home care program

The ability of seniors to remain in the home of their choice will, in many cases, depend on more than access to an emergency response

system. Important as immediate access to help in a crisis may be, seniors often require a variety of services to ensure their safety, security and comfort. Such services may be required on a short or long-term basis to meet health, social or personal care needs. It is important to set emergency response systems in the context of the wider provision of support services that not only increase the opportunities for the elderly to live in the home of their choice but reduce the overall cost of caring for the elderly.

The delivery of the emergency response system should therefore, be integrated into existing home support programs for the elderly. To date, no study exists which evaluates emergency response systems that are linked to medical and community wide support services.

This system could be tested on three groups. The first group should be those who need personal home care. Participants could be drawn from a local long term home care program. This group would be monitored for ability to use the equipment and technology, and to determine the appropriate links to home care services. A control group should be drawn so that comparisons can be made not only on rates of hospital use and institutionalization, but on the impact on the whole support service system.

The second group should be drawn from the elderly who do not require formal personal home care and who are not at high medical risk. This group would receive stand alone systems and be monitored by family and friends. Again, a control group could be used to compare results.

The third group would be an entire senior citizen multiple unit apartment building that is hardwired, but with all other features recommended above. Cost factors, and applicability to all housing

projects with a concentration of the elderly would be of particular interest in the analysis of this part of the study.

Each group would receive the same technical equipment which provides an opportunity to study the impact of this technology, with different monitoring, on different user groups.

In conclusion, there is a growing overlap between the provision of housing and support services for the elderly. This overlap suggests the need for housing providers and policy makers to jointly act on what have traditionally been considered "non-housing issues".

Emergency response systems are an important component in providing cost effective in-home support systems for an aging population. Technologies and programs that contribute to the elderly's desire for independence and need for support services, while reducing the cost to provide shelter, will increasingly be in demand.

The maintenance of independent living in a safe and familiar setting is an important goal of all older Canadians. If technology can permit affordable, safe, independent living to continue, the government should, by all means possible, support the development and implementation of emergency response system programs suitable to community and social support contexts in Canada.